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Lepidoptera

Chapter 11

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Abstract

We provide a comprehensive overview of those Lepidopteran invasions to Europe that result from increasing globalisation and also review expansion of species within Europe. A total of 97 non-native Lepidoptera species (about 1% of the known fauna), in 20 families and 11 superfamilies have established so far in

Europe, of which 30 alone are Pyraloidea. In addition, 88 European species in 25 families have expanded their range within Europe and around 23% of these are of Mediterranean or Balkan origin, invading the north and west. Although a number of these alien species have been in Europe for hundreds of years, 74% have established during the 20th century and arrivals are accelerating, with an average of 1.9 alien Lepidoptera newly established per year between 2000–2007. For 78 aliens with a known area of origin, Asia has contributed 28.9%, Africa (including Macaronesian islands, Canaries, Madeira and Azores) 21.6%, North America 16.5%, Australasia 7.2% and the neotropics just 5.2%. The route for almost all aliens to Europe is via importation of plants or plant products. Most alien Lepidoptera established in Europe are also confined to man-made habitats, with 52.5% occurring in parks and gardens. We highlight four species in particular, *Diaphania perspectalis*, *Cacyreus marshalli*, *Cameraria ohridella* and *Paysandisia archon*, as the most important current economic threats.

Keywords

biological invasion, introduction, pest species, Europe, Lepidoptera, globalisation

11.1 Introduction

Apart from the undoubted impact of climate change, various other facets of human activity, including the increasingly efficient means of transport in the last century, increased trade and globalisation, are having a dramatic effect on the composition of European faunas. Lepidoptera, as a mostly alate and largely phytophagous insect group, are particularly affected, not only by increased transport of the invasive species, but by increased trade in plants and stored plant products. In addition, many species are spreading to hostplants not used in their area of origin.

Lists of naturalized non-native Lepidoptera are already available for a number of European countries (Agassiz 1996a, Essl and Rabitsch 2002, Geiter et al. 2001, Karsholt and Nielsen 1998, Kenis 2005, Šefrová and Laštůvka 2005). In addition, several detailed case studies have been published on the process of invasion to Europe of several non-native Lepidoptera species (Nash et al. 1995, Šefrová 2001, Šefrová 2002a, Šefrová 2002b, Šefrová and Laštůvka 2001, Whitebread 1990). The first list of terrestrial invertebrate species alien to and within Europe included 272 Lepidoptera species, of which 122 were alien to Europe, 139 alien to countries within Europe, and 11 of cryptogenic origin (DAISIE 2008). We substantially revise and update this list here, in the first comprehensive review of known naturalized non-native Lepidoptera known to Europe.

We divided species into two categories:

1. Naturalized exotic species (originating from a continent other than Europe) whose first introduction into Europe appears to be a direct or indirect (deliberate or accidental) result of human activity (Table 11.1). This includes now well known alien lepidoptera such as the Neotropical castniid moth *Paysandisia archon* (Burmeister,

1880) or the South African lycaenid butterfly *Cacyreus marshalli* (Butler, 1898). We also considered in this category species of unknown origin (cryptogenics) such as the leaf-mining moth *Phyllonorycter platani* (Staudinger, 1870). It is worth noting that we also included here species introduced into confined environments like greenhouses which while not apparently spreading of their own accord, have been introduced with their hostplants, with the potential to spread due to horticultural trade. For instance, 11 species of aquatic Pyralidae have been introduced accidentally by man from Asia and North America into Europe, mostly as contaminants of plants. Current climate makes their establishment in the wild unlikely, but global warming could allow their establishment in the near future.

2. European species spreading throughout the continent as a result of human activity (Table 11.2). This category includes the invasive leaf-mining moth *Cameraria ohridella* Deschka and Dimić, 1986, now understood to be Balkan in origin (Valade et al. 2009). It is worth noticing that although many aliens are highly invasive our review also includes naturalised aliens that are not necessarily invasive such as the saturniid moth *Samia cynthia* (Drury, 1773).

We excluded all the following cases, here giving examples:

- i) Species showing clear range expansions/contractions at a country level, which are known to follow global climate change trends (Warren et al. 2001). The butterfly *Colotis evagore* (Klug, 1829) in Spain (Fric, 2005), the processionary pine moth *Thaumetopoea pityocampa* (Denis & Schiffermüller, 1775), in central Europe (Battisti et al. 2005) and several British butterfly species (Asher et al. 2001) are classical examples of this phenomenon. However, it must be noted that *T. pityocampa* has apparently been introduced through human activity from continental Italy to Sardinia (Luciano et al. 2007).
- ii) Naturally-expanding species known as migrants which have established without clear human assistance, such as the choreutid *Tebenna micalis* (Mann, 1857) in Azores (Karsholt and Vieira 2005) and the geometrid *Peribatodes secundaria* (Denis & Schiffermüller, 1775) in Great Britain (Kimber, 2008) as well as rare vagrants that may or may not sporadically naturalize, such as *Acontia crocata* Guenée, 1852 in France (Letellier, 2004); *Pardasena virgulana* (Mabille, 1880) in Great Britain (Honey, 1994) and *Gelechia sabinellus* (Zeller, 1839), *Eccopsis effractella* Zeller, 1848 and *Zophodia grossulariella* (Hübner, 1809), all recently recorded from Great Britain (Agassiz 1978a, Agassiz 1996b, Roche 1982).
- iii) New records of species probably overlooked in particular countries for which there is no clear evidence of range expansion. For instance, in Great Britain the presence of *Bucculatrix ulmifoliae* Hering, 1931 and *Ocnerostoma* spp. (Heath and Emmet 1996, Langmaid et al. 2007).
- iv) Deliberate translocations of species between European countries, such as the introduction of the butterflies *Araschnia levana* (Linnaeus, 1758) (Frohawke, 1940), *Ma-*

culinea arion (Linnaeus, 1758) (Thomas et al. 2009) and *Lycaena dispar* (Haworth, 1803) (Ford, 1945) into Great Britain. These translocations result from solitary enthusiasts or are for conservation management purposes including the reintroduction of extinct species, but have nothing to do with our subject of biological invasion, essentially the aspects associated with increased globalisation.

- v) Species once apparently established but now extinct (e.g. in Great Britain, the blastobasid *Blastobasis phycidella* (Zeller, 1839) and the oecophorid *Euclemensia woodiella* (Curtis, 1830) (Emmet 1988, Koster and Sinev 2003)
- vi) The large number of living display species (this is the case of butterfly houses), unless these species are either establishing in the wild, or there is evidence they have become greenhouse pests (we have no examples). Nevertheless, we highlight the risks involved in importation of butterflies for butterfly houses and for a new practice of wedding releases.

Finally, the introduction of exotic host plants by man has indirectly allowed several lepidopteran species to expand their distribution range. We consider as alien species *Stigmella speciosa* Frey, 1857, *Caloptilia rufipennella* (Hübner, 1796) and *Phyllonorycter geniculella* (Ragonot, 1874), all feeding on *Acer pseudoplatanus* in northern Europe; *Stigmella suberivora* (Stainton, 1869) feeding on *Quercus ilex* in Great Britain; *Eupithecia phoeniceata* (Rambur, 1834) feeding on *Juniperus* and various Cupressaceae in Belgium and Great Britain, *Cydia grunertiana* (Ratzeburg, 1868) in Belgium, Denmark and Sweden; *C. illutana* (Maslov, 1988) and *C. pactolana* (Zeller, 1840) feeding on *Larix*, the last two in Great Britain; *Thera cupressata* (Geyer, 1831), feeding on imported *Abies* in Sweden and Cupressaceae in Great Britain, and *Lithophane leautieri* (Boisduval, 1829) on Cupressaceae cultivars in Great Britain. *Polychrysia moneta* (Fabricius, 1787) started to spread as early as 1891 in Europe, possibly as a result of rise in popularity of ornamental hostplants such as *Delphinium* in gardens (Agassiz, 1996a). Other well known examples of species which have followed the invasion of their host plants are the milkweed butterflies, *Danaus plexippus* (Linnaeus, 1758) and *Danaus chrysippus* (Linnaeus, 1758). The larvae of both species feed on ornamental and invasive milkweeds (Apocynaceae) which have been introduced in some Macaronesian islands and the Iberian Peninsula (Baez, 1998).

We summarise the relative importance of naturalized alien invasives by family, in relation to their proportion in the relatively well known European fauna, finding great disparities in their prevalence.

11.2 Diversity of alien lepidopteran species

Lepidoptera is one of the largest insect orders, with around 175,000 described species in 128 families and 47 superfamilies (Kristensen and Skalski 1999, Mallet 2007). About 9,428 native species in 83 families and 31 superfamilies have been recorded in

Europe (Karsholt and Kristensen 2003). A total of 97 non-native Lepidoptera species, in 20 families and 11 superfamilies have established so far in Europe (Table 11.1). Our analysis reveals that there is a significant correlation between the number of alien species and the number of native species per family (Spearman's rho correlation: $r = 0.48$, $P < 0.001$). In addition, 88 European species in 25 families have expanded their range within Europe and many of these are of Mediterranean origin, invading northern and western areas of Europe (Table 11.2).

The 20 families which contain alien species to Europe are: Pyralidae (30 species), Tortricidae (10), Gracillariidae (8), Tineidae (7), Noctuidae (6), Gelechiidae (6), Blastobasidae (5), Yponomeutidae (4), Oecophoridae (4), Cosmopterigidae (3), Saturniidae (3), Pterophoridae (2), Nymphalidae (2) and Bucculatricidae, Agonoxenidae, Lycaenidae, Geometridae, Arctiidae, Nolidae and the alien family Castniidae, each with one species (Table 11.1).

Agonoxenidae: Sixteen species of agonoxenids are native to Europe. The Asian species *Haplochrois theae* (Kusnezov, 1916) represents the only alien. During the 20th century this was a serious pest on tea plantations in Georgia and to a lesser degree, in the Krasnodar Territory of Russia (Sinev, 1994).

Arctiidae: One hundred and one species of arctids are native to Europe but only one species, the North American Fall Webworm, *Hyphantria cunea* (Drury, 1773), is alien to the region. The larvae are highly polyphagous, feeding on hundreds of different species of deciduous trees on which they form conspicuous webbed nests in late summer and autumn.

Blastobasidae: Only 41 species of native blastobasid moths have been recorded in Europe, a large evolutionary radiation of which 26 species occur in Madeira (Karsholt and Sinev 2004). However, the number of alien species in this family (five) is relatively high, mainly because the larvae feed usually on dead organic matter. Some species, such as *Blastobasis lacticolella* (Rebel, 1940) are pests of stored foodstuffs. Interestingly, all alien Blastobasidae appear to have colonized continental Europe (mostly Great Britain and/or mainland Portugal) from Madeira, presumably with the import of ornamental plants. The common species *B. adustella* Walsingham, 1894 (originally described as a form of *B. lignea* Walsingham) (Sinev, 2007) is another example. However, *B. adustella* has widely been treated, erroneously, as a synonym of the Madeira endemic species *B. vittata* Wollaston, 1858. Although there are records attributed to *B. vittata* on the internet, including from the British Isles, there are no unambiguously identified instances of the introduction of this species outside Madeira at present.

Bucculatricidae: There are 53 native bucculatricids known in Europe. One macaronesian species, *Bucculatrix chrysanthemella* (Rebel, 1896), was recently introduced from the Canaries into Italy and France, where it seems to have established populations. This species has also recently been recorded from Finland, at which latitudes it seems unlikely to become established (Siloaho, 2008). *B. chrysanthemella* attacks Paris Daisy (*Argyranthemum frutescens*), an economically important ornamental crop in some parts of Europe.

Castniidae: This family has no native species in Europe. The majority of castniid moths are Neotropical, while some species are also found in Australia and South-east

Asia. The Neotropical *Paysandisia archon* is the only alien castniid known to occur in Europe and is currently spreading along the Mediterranean coast attacking a wide range of palm species. The castniid *Riechia acraeoides* (Guérin-Méneville, 1832) is one of numerous sporadic adventives included in the previous list (DAISIE 2008) that we discount here.

Cosmopterigidae: There are 79 species of cosmopterigids native to Europe, with three species considered as aliens. Two of these are African species that feed on *Acacia* in Malta. The larvae feed internally on the leaves, seeds and stems of their hostplants. There is no evidence that *Cosmopterix pulchrimella* Chambers, 1875, recently established in Cornwall, Great Britain, arrived there directly through human agency.

Gelechiidae: There are 697 species of gelechiids known to occur in Europe. The larvae of most species are concealed feeders on plant tissues, many of them feeding internally in seed heads and fruits, some mining and even producing galls. Six alien gelechiids are known from Europe, among them major agricultural pests such as the Tomato Leafminer *Tuta absoluta* (Meyrick, 1917), the cosmopolitan Angoumois Grain Moth *Sitotroga cerealella* (Olivier, 1789), which attacks stored whole cereal grains, and the Pink Bollworm *Pectinophora gossypiella* (Saunders, 1844), whose larvae bore into the flowers and seeds of cotton.

Geometridae: There are 1,024 species of geometrids native to Europe, but only one non-native species appears to have naturalized in Europe. This is *Pseudocoremia suavis* (Butler, 1879), an endemic geometrid to New Zealand (Berndt et al. 2004), which was recorded on five separate occasions in Cornwall in 2007 (James 2008, Skinner 2009), suggesting establishment in the wild. This species, polyphagous on various gymnosperms, represents a potential risk to European conifer forests.

Gracillariidae: There are 249 species of native gracillariids known in Europe and eight alien species have been recorded. Among these are pests of economic importance, such as the Citrus Leafminer *Phyllocnistis citrella* Stainton, 1856.

Lycaenidae: One hundred and thirty-six species of lycaenids are native to Europe. The South African *Cacyreus marshalli* is one of the few butterflies which are naturalised aliens in Europe (see also under Nymphalidae). This is a pest of cultivated *Pelargonium* plants, mainly in Mediterranean region but it was found to be breeding in Great Britain in 1997 (Lewes, East Sussex), where it became temporally established in greenhouses until May 1998 but was eradicated (Holloway, 1998).

Noctuidae: This is the most species-rich family of Lepidoptera in Europe, with over 1,435 native species. Six alien noctuids have been recorded so far, including some major agricultural pests such as *Chrysodeixis eriosoma* (Doubleday, 1843) and *Spodoptera litura* (Linnaeus, 1758). However, on a cautionary note, these genera are known to have strong migratory tendencies. Indeed we may never know, due to lack of sufficient historical records, when or whether certain noctuids arrived as invasives to Europe or by artificial agency. One good example of this is *Araeopteron ecphaea* (Hampson, 1914) (type locality Nigeria). It is also interesting to note the African and Austral-Oriental fern-feeding species *Callopietria maillardi* (Guenée, 1862) seems to have been accidentally imported with *Nephrolepis* ornamental ferns, but this species has five subspecies and the precise origin

of the introduced individuals is unknown. Some records of *Chrysodeixis acuta* (Walker, 1858) could also represent misidentifications of *C. chalcites* (Esper, 1789). Following our exclusion criteria, we have not included singleton records, for example of *Acontia crocata* Guenée, 1852, a specimen of which was collected in Irais (Deux-Sevres), France (Letellier, 2004), possibly resulting passively from a plant import from SE Asia (Hacker et al. 2008).

Nolidae: Thirty-five species of nolidids are native to Europe, but only one exotic species has repeatedly been recorded within the region, the Spotted Bollworm, *Earias vittella* (Fabricius, 1794). The larva of this species feeds on several plants of the family Malvaceae, in particular Okra (*Abelmoschus esculentus*) pods, *Gossypium* (it is one of the most important pests of cotton) and *Hibiscus*. It has been found as a vagrant in Great Britain and seems to also be present in southern Spain (Nash, 2003). Its establishment needs to be confirmed.

Nymphalidae: There are 239 species of nymphalid butterflies native to Europe. Two non-native danaine species, the Monarch butterfly *Danaus plexippus* and the Plain Tiger *D. chrysippus* have established themselves in the Macaronesian islands and Iberian Peninsula. We have included both species despite them being well known migrants because their introduction and establishment in Europe has followed the invasion and establishment in Europe of their Apocynaceae host plants (*Asclepias curassavica*, of Neotropical origin and *Gomphocarpus fruticosus* of Afrotropical origin). Thus, the Monarch's range has greatly expanded during the 19th and 20th centuries from North America and now encompasses numerous Atlantic, Pacific and Indian Ocean islands and Australia. A number of hypotheses have been developed to explain this great range expansion (Vane-Wright 1993).

Oecophoridae: There are 120 native species of oecophorids in Europe. Only four alien oecophorids are established in the region, three of which feed on dead plant material.

Pterophoridae: There are 166 native pterophorids known to Europe. Two species, *Megalorhipida leucodactylus* (Fabricius, 1794) and *Lantanophaga pusillidactylus* (Walker, 1864) are known to be alien to Europe. *M. leucodactylus* has a circum-tropical distribution and has established populations in Sicily (Bella and Ferrauo 2005) and Israel. It has also been recorded in Spain, but its presence there needs confirmation (Gielis, pers. comm.). The larvae feed on Amaranthaceae, Cucurbitaceae, Goodeniaceae, Leguminosae, Nyctaginaceae, Rosaceae and Asteraceae (Vargas, 2007). The Lantana Plume Moth *L. pusillidactylus* is also a pantropical species whose origin, as for *M. leucodactylus*, is not clear. This species has been introduced with its Verbenaceae hostplant (which is of neotropical origin), *Lantana camara*, into Spain, Portugal and southern Italy (Aguilar and Karsholt 2006, Bella and Marchese 2007, King 2000). The moth is used as the biocontrol agent against this plant, itself an invasive in many parts of the world.

Pyraloidea (Pyralidae and Crambidae): This superfamily has 898 native species known in Europe. Pyraloidea also has the highest number of species (30) alien to Europe. This is probably due to the high number of alien crambid pyrales that have larvae feeding on submerged and floating aquatic plants used in aquariums and ponds (11 species) as well as cosmopolitan pests that feed on stored products (seven species). These invasives include the North American wax moth *Vitula edmandsii* (Packard, 1865), whose larvae damage the combs of honeybee and bumblebee nests.

Saturniidae: Seven saturniids are native to Europe. Three Asian species have deliberately been introduced into Europe for silk production, but have naturalized from escapes. This family is also very popular among amateur breeders and sometimes there are reports of adult moths of a wide number of species in urban areas.

Tineidae: There are 262 species of native tineids in Europe and seven alien species have also been recorded to the region. At least five of these feed on stored products, cloths, and detritus, such as the Common Clothes Moth (*Tineola bisselliella* (Hummel, 1823)), whose larvae feed on clothing and natural fibres.

Tortricidae: About 977 species of tortrix moths have been recorded as native to Europe. Among the 10 alien species recorded to Europe, there are some economically important pests, in particular of apple trees, for example the oriental fruit moth (*Grapholita molesta* (Busck, 1916)) and the light brown apple moth *Epiphyas postvittana* (Walker, 1863). Larvae of the latter species are not easily distinguished from the larvae of other tortricid leafrollers; only DNA-based testing appears to work reliably for identification. Interestingly, half of the tortricids recorded as alien to Europe (five out of 10 species) are specialists on *Cedrus* and have been introduced into southern France, where plantations of these trees are common.

Yponomeutidae: There are 113 species of ermine moths native to Europe, with four alien species having been recorded. The larvae tend to form communal webs, and some species are agricultural forestry pests, such as the Arborvitae Leafminer, *Argyresthia thuiella* (Packard, 1871) and *Prays citri* (Millière, 1873), a well-known *Citrus* pest in the Mediterranean region. Two North American leafminers of the genus *Argyresthia* attack Cupressaceae in Europe.

In our analysis, it is interesting that we found a similar number of alien species to Europe (Table 11.1) as species that have expanded their range within Europe due to human activity (Table 11.2). Indeed, there is a significant correlation between the number of alien species per family to Europe and the number of alien species per family within Europe (Spearman's rho correlation: $r = 0.39$, $P = 0.044$). However, several families exhibit some species which have expanded their range within Europe, yet have very few or no recorded aliens to Europe. For instance, strikingly, Geometridae features only one species alien to Europe within a fauna of 1,024 species, a number of which are known migrants, whereas as many as 11 species have been recorded invading other countries within Europe (Table 11.2). The North American sterrhine geometrid *Idaea bonifata* (Hulst, 1887) has been intercepted several times with imports of dried plant material but, as far as known, is not yet established in Europe (Martinez and Coutin 1985).

The absence of alien species within other species-rich families, such as Coleophoridae (533 spp.), Nymphalidae (239 spp.), Psychidae (231 spp.), Nepticulidae (242 spp.) and Sphingidae (39 spp.) is also notable. In spite of the known high mobility of the last family, several exotic species (i.e. the American *Sphinx drupiferarum* Smith, 1797, *Agrius cingulatus* (Fabricius, 1775) and the African *Polyptychus trisecta* (Aurivillius, 1901)) have been recorded (sometimes repeatedly) within the region, with no confirmed establishment (Marabuto 2006, Pittaway 1993, Waring et al. 2003).

11.3 Temporal trends

The precise date of arrival is not known for two species. An analysis of the 95 species for which the date of the first record in Europe is known shows that the arrival of alien Lepidoptera has dramatically accelerated during the second half of the 20th century (Figure 11.2). This trend is still increasing, with an average of 1.9 alien Lepidoptera newly established per year in Europe between 2000 and 2007 (Figure 11.2). This average is twice that during the period 1975 to 1999 (1.1 species per year). The same trend has been observed for all groups of alien terrestrial invertebrates analysed together (Roques et al. 2008). This temporal trend might be due to the acceleration of processes that happened in much wider time frames in the past, such as global climate change and human assisted transportation via the much faster and more efficient means of transport nowadays.

Alien species have historically been introduced for centuries, so it should not be considered that invasive species are necessarily a 20th century phenomenon, although the poor documentation of older cases inevitably also provides more scope for speculation. One such case is *Euclémensia woodiella*, belonging to a North American oecophorid lineage (Koster and Sinev 2003) found in numbers near Manchester in 1829 and not since. A much older potential example is the lasiocampid *Pachypasa otus* (Drury, 1773) with a scattered distribution in southern Italy, whose larva feeds mainly on *Cupressus*, could even have been introduced by the Romans for “Coan” silk production, as it possibly represents the “Assyrian Bombyx” mentioned in Naturalis Historia by Plinius (Good, 1995).

11.4 Biogeographic patterns

For at least 19 alien species, the precise area of origin is not known and these we consider as cryptogenic. We have classified *Phyllonoryctyer platani* (Gracillariidae) as cryptogenic because there are some doubts regarding its origin (Šefrová, 2001). Thus, *P. platani* is either of North American origin and was introduced to Europe with American *Platanus occidentalis*, or it originated in Southeastern Europe and Southwestern and Central Asia, on *Platanus orientalis*. We have included *C. ohridella* as alien within Europe (Table 11.2) since recent genetic studies suggest a Balkan origin as most likely (Valade et al. 2009).

An analysis of the 78 alien species for which the native area of origin is known, shows that Asia has contributed the most alien species with 28.9% (28 out of 97 species) (Figure 11.3). Africa (including Macaronesian islands, Canaries, Madeira and Azores) supplied 21.6% of alien species (21 out of 97 species) followed by North America with 16.5%, Australasia with 7.2%, and the Neotropics, surprisingly few with 5.2%.

Large differences exist among European countries in the number of alien Lepidoptera recorded per country (Figure 11.4). With 42 species, the United Kingdom is the

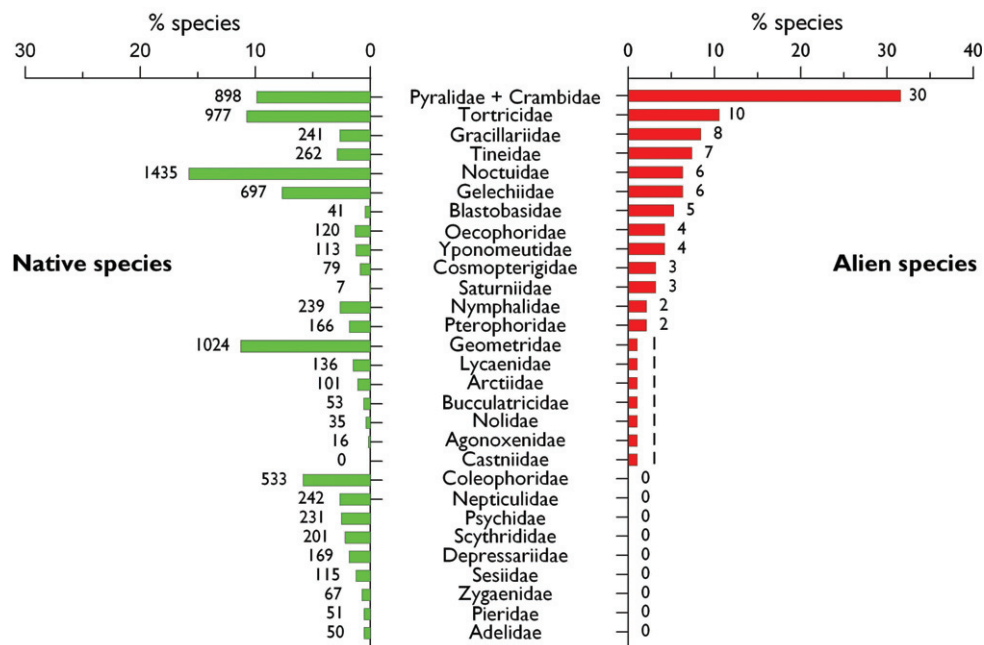


Figure 11.1. Comparison of the number of species per family of Lepidoptera in the alien and native entomofauna in Europe. Families are presented in a decreasing order based on the number of alien species. Only the most important families of native species (> 50 spp.) have been considered.

European country with the highest number of alien Lepidoptera, followed by France (mainland) with 41 and Spain (mainland) with 39 species. Both Moldavia and Luxemburg are the European countries with the lowest number (with one alien species each). These differences are very likely to result at least partly from variation in sampling effort and the availability of local taxonomic expertise, but the area and the geographical location of a country is also a very important factor, in this respect.

11.5 Main pathways and vectors to Europe

As far as we know, most Lepidoptera alien to Europe have been introduced accidentally (96.9%). A clear exception is some saturniid species that were imported from Asia into Europe for silk production in the nineteenth century, and subsequently became naturalized, including in urban areas. On the other hand, the Silkmoth *Bombyx mori* Linnaeus, 1758, has not been included in the analysis, because although it is widespread in captivity throughout Europe, its flightlessness has prevented naturalisation.

The import of ornamental plants (particularly palms, geraniums and azaleas) is most likely responsible for the introduction of several species such as *Paysandisia archon*, *Cacyreus marshalli* and *Caloptilia azaleella*. Transport also plays an important role in the dispersal of some species, including ones alien within Europe. For instance, *Cameraria*

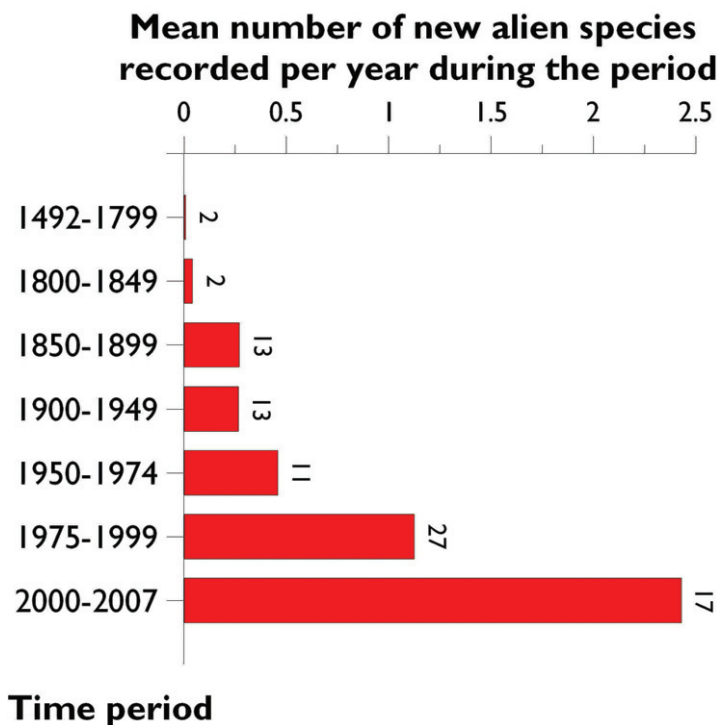


Figure 11.2. Rate of established alien Lepidoptera in Europe since 1492 as mean number of alien Lepidoptera recorded per year. Calculations are made on 95 alien species for which the first record is precisely known. Numbers above bars indicate number of new species recorded per period.

obridella seems to feed almost exclusively on *Aesculus hippocastanum* trees planted in urban areas and parks. The main means of its spread is likely to be wind dispersal, but human assisted transportation played a major role in the long distance dispersal of this species (Gilbert et al. 2004). Since the advent of tropical butterfly houses in the 1980s, a potential new threat has emerged, the use of mass butterfly releases for weddings, a practice increasingly popular in countries such as Italy, where one of us (AZ) has recorded a number of exotic species flying freely in cities. Usually Monarch butterflies are used, but less scrupulous companies may be using a range of exotics, many of which are likely to find climate change and the availability of hostplants for some papilionid butterflies, such as Rutaceae planted in city gardens propitious for establishment of at least temporary populations.

11.6 Most invaded ecosystems and habitats

Most alien Lepidoptera are phytophagous (78.3%), whereas detritivores represent only 21.6% (Table 11.1). The majority of alien Lepidoptera established in Europe are confined to man-made habitats, and only a few species have become established in a more or less natural environment, mostly in woodlands. Examples of the latter include the

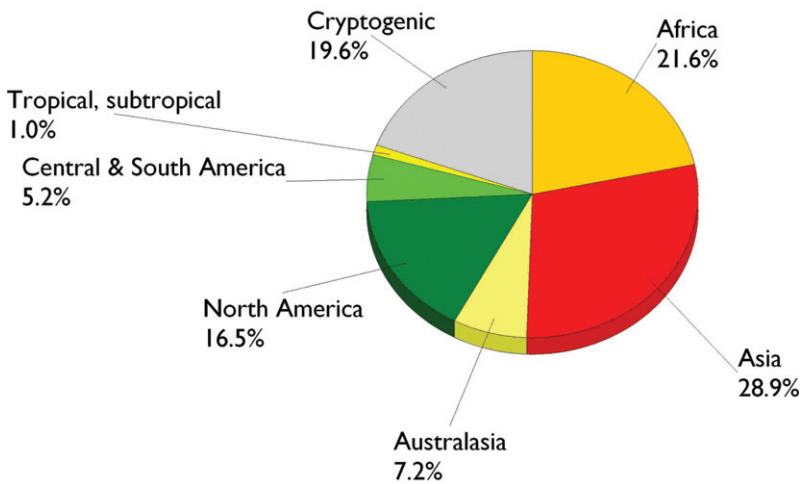


Figure 11.3. Regions of origin of the Lepidoptera species alien *to* Europe

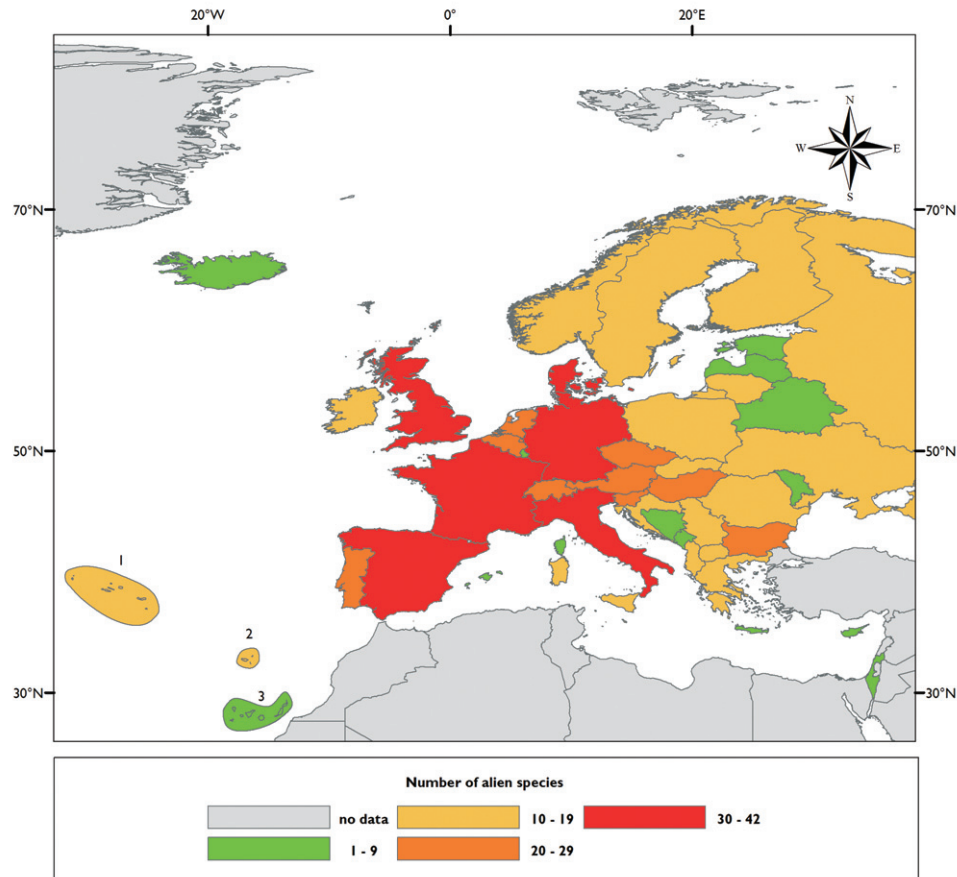


Figure 11.4. Colonization of continental European countries and main European islands by Lepidoptera species alien *to* Europe.

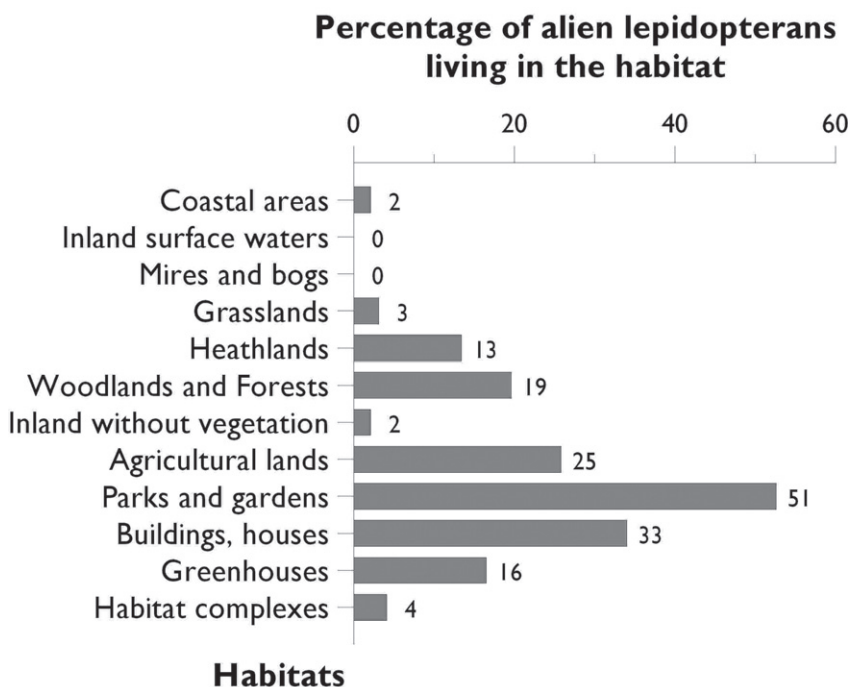


Figure 11.5. Main habitats of 97 alien Lepidoptera species established in Europe (note that a species may live in several habitats).

arctiid *Hyphantria cunea*, the gracillariid *Phyllonorycter issikii* in Central Europe and the saturniid *Antheraea yamamai* in the Balkans.

In Europe, most alien Lepidoptera species feed on their original hostplants. However, some species seem to have been able to switch to other hostplants that are often closely related. For instance, *Paysandisia archon* specializes on *Trithrinax campestris* (Arecaceae) and to a lesser extent on *Cocos yalae* in its native area (Argentina, Uruguay).

However, in Europe this moth has expanded its host range to many ornamental exotic palms (*Phoenix canariensis*, *Latania* sp.) as well as posing a threat to the native *Chamaerops humilis* (Montagud Alario 2004).

About 50.5% of alien Lepidoptera live indoors in domestic, industrial and other artificial habitats such as 16.5% in greenhouses (Figure 11.5). Six out of the nine species that feed on stored products show a cosmopolitan distribution. Parks and gardens host 52.6% of alien species, where they are frequently introduced with their native hostplant, while 25.8% have colonized agricultural land (Figure 11.5).

11.7 Ecological and economic impact

The impact of most alien Lepidoptera species has not been quantified in detail. However, negative economic impact has been recorded for 16 alien species. The Indian

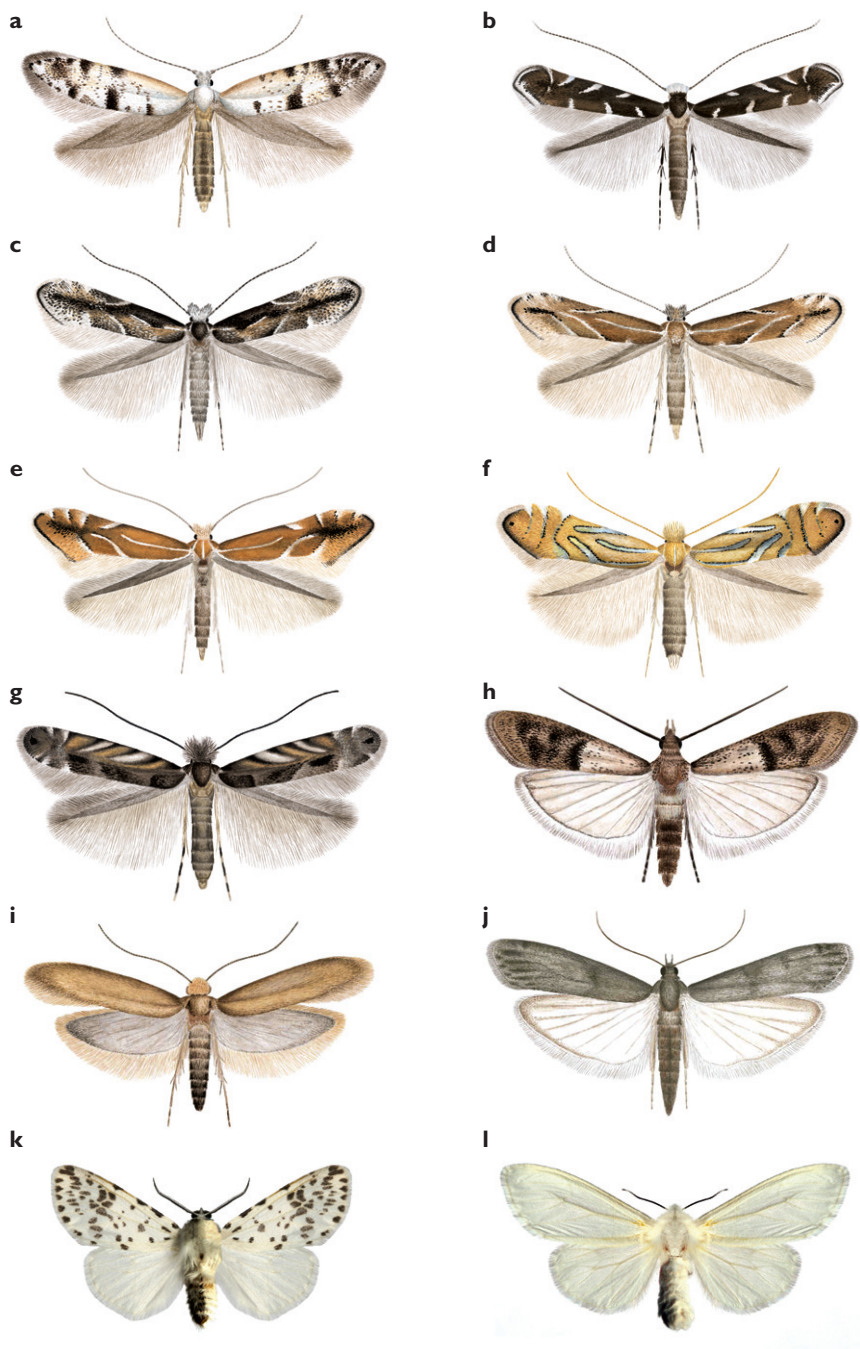


Figure 11.6. Adult habitus of some lepidopteran species alien to Europe: **a** *Argyresthia thuella* **b** *Parectopa robinella* **c** *Phyllonorycter issikii* winter form **d** *Phyllonorycter issikii* summer form **e** *Phyllonorycter leucographella* **f** *Phyllonorycter platani* **g** *Phyllonorycter robinella* **h** *Plodia interpunctella* **i** *Tineola bisselliella* **j** *Ephesia kuehniella* **k** *Hyphantria cunea* male **l** *Hyphantria cunea* female (drawings by Aleš Laštůvka).

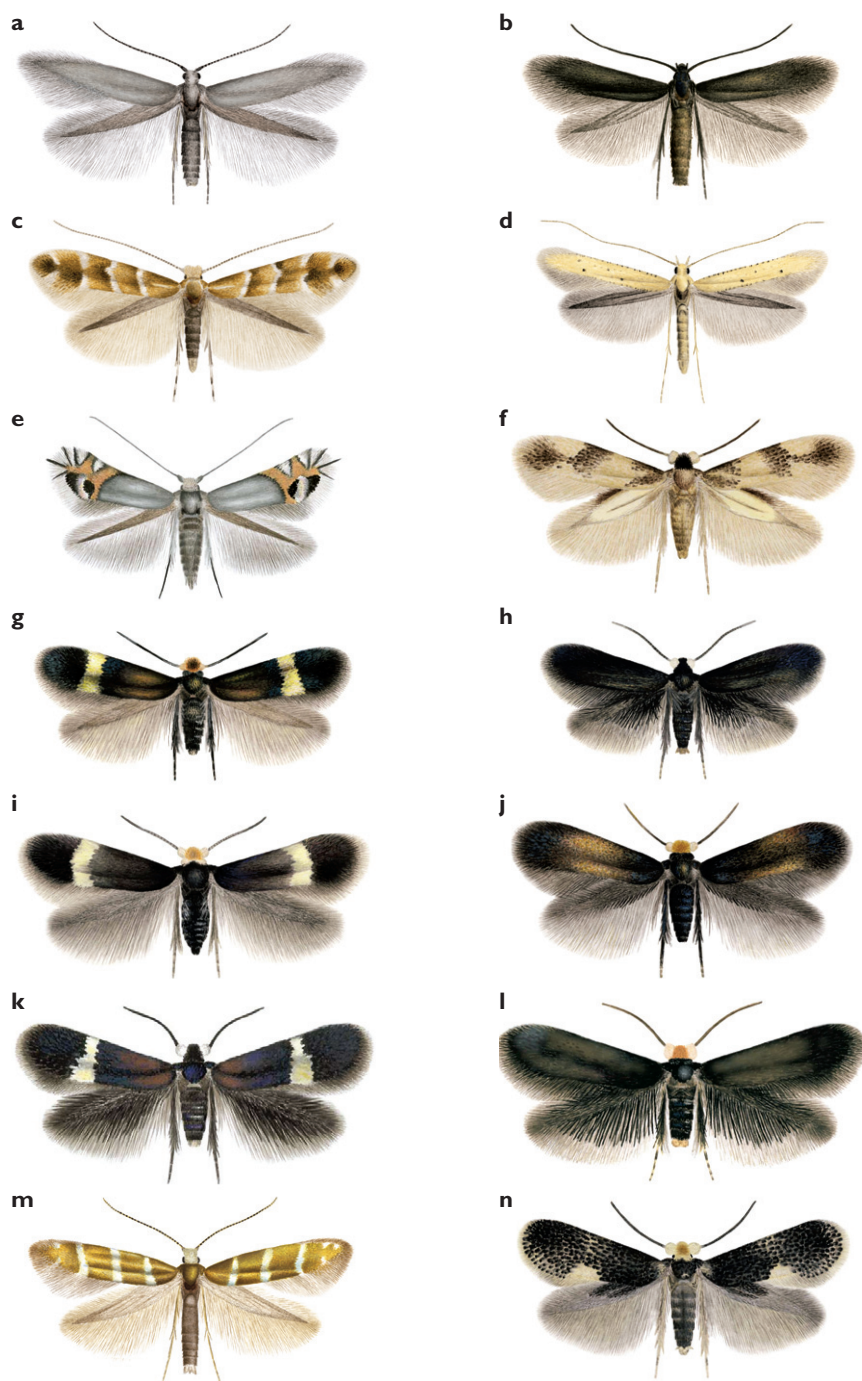


Figure 11.7. Adult habitus of some lepidopteran species alien in Europe: **a** *Coleophora laricella* **b** *Coleophora spiraeella* **c** *Cameraria ohridella* **d** *Caloptilia roscipennella* **e** *Leucoptera malifoliella* **f** *Acalypttris platani* **g** *Stigmella aurella* **h** *Stigmella atricapitella* **i** *Stigmella centifoliella* **j** *Stigmella pyri* **k** *Stigmella speciosa* **l** *Stigmella suberivora* **m** *Argyresthia trifasciata*; **n** *Ectoedemia heringella*. (drawings by Aleš Laštůvka).

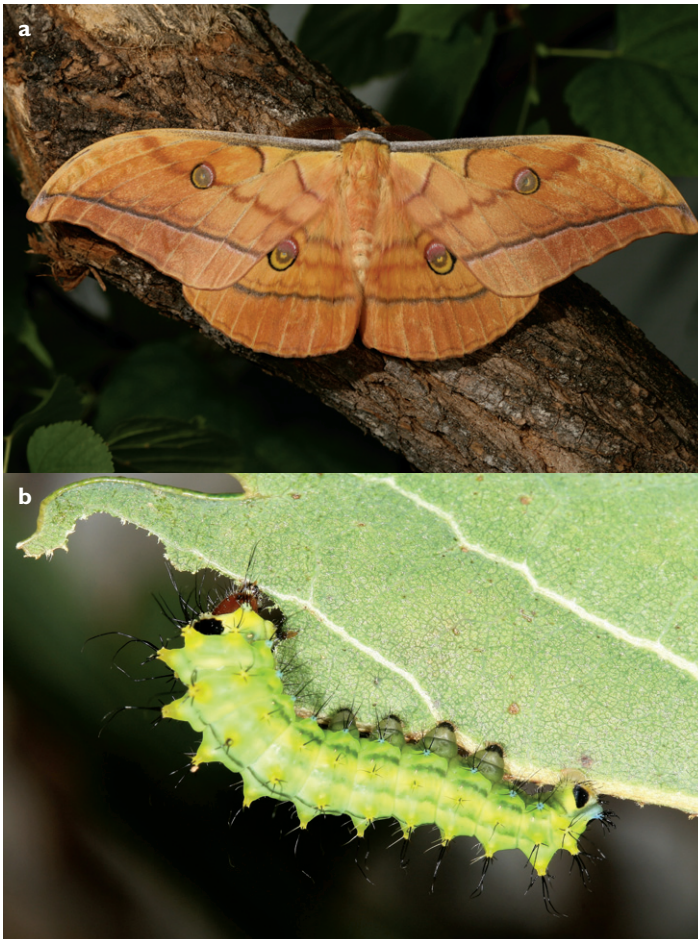


Figure 11.8. Alien saturnid originating from Asia, *Antherea yamamai* **a** adult **b** 2nd instar larva (credit Zdenek Laštůvka)

Meal Moth *Plodia interpunctella* (Hübner, 1823) may severely affect grain and grain products, dried fruits and seeds in households and warehouses. The Common Clothes Moth *Tineola bisselliella* is another example of a major pest in houses where it feeds on clothes, carpets, rugs, and upholstered furniture. However, along with several other tineids, this species has become rare due to the increase in use of man-made fibres and the dry environment created by central heating (Kimber, 2008). The most serious alien lepidopteran pests in orchards in many parts of Europe include *Grapholita molesta*, *Hyphantria cunea* and *Prays citri*.

Some species can also cause aesthetic impact. Thus, species causing severe infestations can lead to almost complete defoliation of the hostplants. For instance, *C. obridella* causes premature defoliation of the white-flowered horse-chestnut, *Aesculus hippocastanum*. The trees do not die but the aesthetic impact is so severe that in some countries, heavily infested trees have been felled and removed.



Figure 11.9. Clearwings (Sesiidae) alien in Europe. **a** *Pennisetia hylaeiformis* ♂ **b** *Synanthedon andrenaeformis* ♂ **c** *Synanthedon myopaeformis* ♂. (credit Zdenek Laštůvka)

Little is known, however, about the ecological impact of alien Lepidoptera in natural areas of Europe (Kenis et al. 2009). Four alien Lepidoptera species seem to have a potentially important ecological impact: 1) the recently introduced pyralid *Diaphania perspectalis* that could represent a serious threat to topiary Box hedges and plants in nurseries, parks and gardens, and *Buxus* shrubs growing in the wild; 2) *C. ohridella*, that recent studies suggest could have a potential negative impact on native leafminers via apparent competition and could be adapting to *Acer* species in some areas (Péré et al. 2009); 3) the lycaenid *Cacyreus marshalli*, which threatens both native geraniums and *Geranium*-consuming lycaenids (Quacchia et al. 2008); 4) finally, as previously mentioned, *Paysandisia archon* represents a serious threat to the conservation of natural populations of *Chamaerops humilis*, the only native palm in Europe (Montagud Alario 2004, Sarto i Monteys 2002).

Lastly, we recommend that in order to guarantee the well being of natural ecosystems and also to keep track of future additions to the European alien Lepidoptera list, natural areas of special conservation concern like those under the Natura-2000 framework should be monitored more intensively and regularly for the early detection of potential threats, which according to our results are expected to increase.

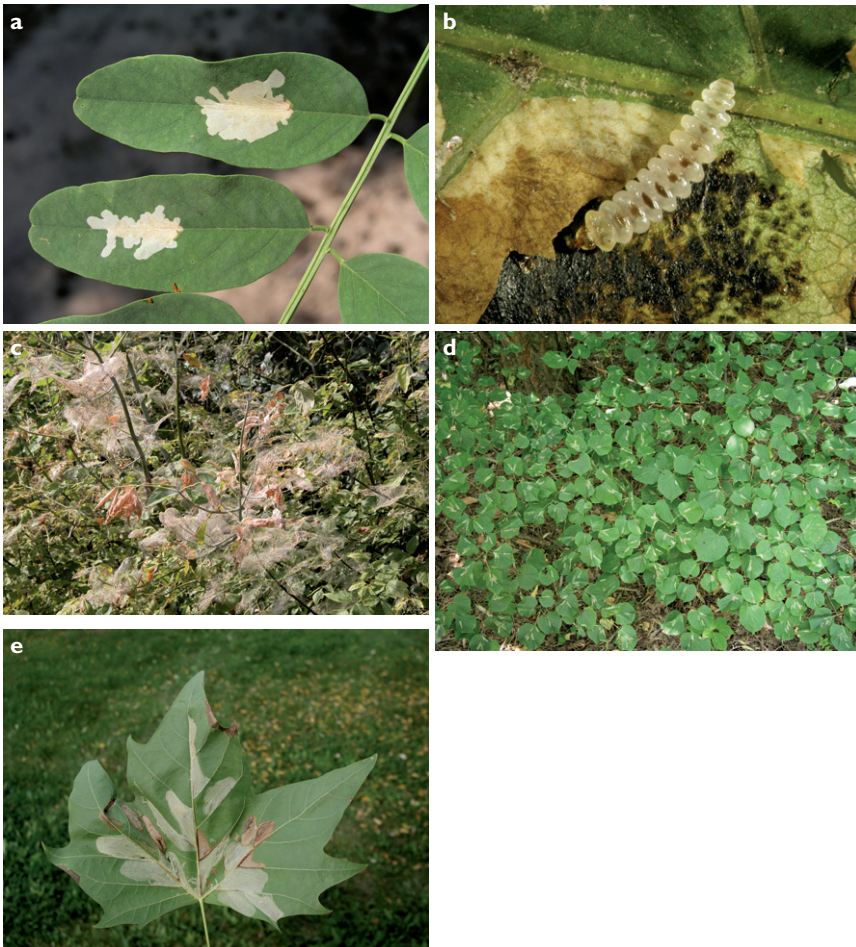


Figure 11.10. Damage by alien lepidopteran larvae. **a** mines of *Parectopa robiniella* on *Robinia* **b** 3rd instar larva of *Cameraria ohridella* extracted from its mine on *Aesculus* **c** damage of *Hyphantria cunea* on *Acer negundo* **d** mines of *Phyllonorycter issikii* on *Tilia* **e** mines of *Phyllonorycter platani* on *Platanus* (Credit: Hana Šefrová).

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Table 11.1. List and characteristics of the lepidopteran species alien to Europe. Status: **A** Alien to Europe **C** cryptogenic species. Country codes abbreviations refer to ISO 3166 (see appendix I). Habitat abbreviations refer to EUNIS (see appendix II). Last update 01/06/2009

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
Arctiidae								
<i>Hyphantria cunea</i> (Drury, 1773)	A	Phytophagous	North America	1949, YU	AL, AT, BA, BG, CH, CZ, DE, DK, EE, FR, DE, GR, HR, HU, IT, LT, MD, ME, MK, PL, RO, RS, RU, SI, SK, GB	G5, I1, I2G	Polyphagous on deciduous trees (<i>Acer negundo</i> , <i>Populus</i> , <i>Morus</i> , <i>Prunus</i> , <i>Juglans</i>)	Buszko and Nowacki (2000), Essl and Rabitsch (2002), Gaedike and Heinicke (1999), Huemer and Rabitsch (2002), Ippolito and Parenzan (1981), Janežič (1968), Karsholt and Nielsen (1998), Luig and Kesküla (1995), Montermini (1985), Rezbanyai-Reser (1991), Šefrová and Laštůvka (2005), Yaroshenko (1972), Surányi (1946), Torp (1987)
Agonoxenidae								
<i>Haplochromis theae</i> (Kusnezov, 1916)	A	Phytophagous	Asia	1915, RU	RU	I1	<i>Thea</i> , <i>Camellia</i>	Demokidov (1916), Koster and Sinev (2003)
Blastobasidae								
<i>Blastobasis adustella</i> Walsingham, 1894	A	Detritivorous	Africa, Macaronesia (PT-MAD)	1902, IE	BE, FR, GB, IE, NL	G5, I2, J6	Decaying vegetal material	Aguiar and Karsholt (2006), De Prins et al. (2009), Karsholt and Sinev (2004)
<i>Blastobasis decolorella</i> (Wollaston, 1858)	A	Detritivorous	Africa, Macaronesia (PT-MAD)	1946, PT	PT	F5, G5, I2, J1, J6	Wide variety of foodstuffs, including leaf-litter, vegetation, and stored products	Corley et al. (2006), Karsholt and Sinev (2004)
<i>Blastobasis lacticolella</i> Rebel, 1940	A	Detritivorous	Africa, Macaronesia (PT-MAD)	1946, GB	GB, IE	G5, I2, J6	Decaying vegetal material	Aguiar and Karsholt (2006), Karsholt and Sinev (2004)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Blastobasis maroccanella</i> Amsel, 1952	A	Detriti- vorous	Africa, Macaronesia (PT-MAD)	1990, PT	ES, FR, PT	B, F5, G5, I2, J6	Decaying vegetal material	Passos de Carvalho and Corley (1995)
<i>Blastobasis rebeli</i> Karsholt & Sinev, 2004	A	Detriti- vorous	Africa, Macaronesia (PT-MAD)	1998, GB	GB	G5, I2, J6	Decaying vegetal material	Aguiar and Karsholt (2006), Karsholt and Sinev (2004)
Bucculatricidae								
<i>Bucculatrix chrysanthemella</i> (Rebel, 1896)	A	Phyto- phagous	Africa (Macaronesia)	2007, IT	FI, FR, IT	I2	<i>Argyranthemum frutescens</i>	Cocquempot and Nel (2009), Constanzi et al. (2008), Klimesch (1979)
Castniidae								
<i>Paysandisia archon</i> (Burmeister, 1879)	A	Phyto- phagous	Neotropics (South America)	c.1995, ES	CY, DK, ES, ES-BAL, FR, GR, GR-CRE, IT, IT-SIC, SI	I2, J100	Palm trees (<i>Phoenix</i> spp, <i>Thrininx</i> , <i>Chamaecrops</i> , <i>Livistona</i> , <i>Trachycarpus</i> , <i>Washingtonia</i>).	Aguilar et al. (2001), Colazza et al. (2005), Espinosa et al. (2003), Hollingsworth (2004)
Cosmopterigidae								
<i>Anatrachyntis simplex</i> (Walsingham, 1891)	A	Phyto- phagous	Asia- Tropical	1999, PT	CY, ES, GB, PT	J1	Polyphagous, cotton, pomegranate fruits	Heckford (2004), Koster and Sinev (2003)
<i>Ascalenia acaciella</i> Chrétien, 1915	A	Phyto- phagous	Africa	2001, MT	MT	I2	<i>Acacia</i>	Koster and Sammut (2006)
<i>Bifascioides leucomelanellus</i> (Rebel, 1917)	A	Phyto- phagous	Africa	2004, MT	MT	I2	<i>Acacia</i>	Koster and Sammut (2006)
Gelechiidae								
<i>Coloretechnites piceella</i> (Kearfott, 1903)	A	Phyto- phagous	North America	1952, GB	AT, CZ, DE, FR, GB, HU, IT, SK	G3, G5, I2	<i>Picea</i>	Essl and Rabitsch (2002), Hill et al. (2005), Huemer and Rabitsch (2002), Reiprich (1991), Šumpich et al. (2007)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Pectinophora gossypiella</i> (Saunders, 1844)	A	Phytophagous	Australasia	1935, IT	AL, BG, ES, GR, GR-CRE, IL, IT, IT-SIC	I1	Cotton	Karsholt and Nielsen (1986), Povolny (1996), Roll et al. (2007), Russo (1939)
<i>Phthorimaea operculella</i> (Zeller, 1873)	A	Phytophagous	Neotropics (South America)	1899, MT	AL, AT, BE, BG, DK, ES, GB, GR, HU, IL, IT, IT-SAR, IT-SIC, MK, MT, NL, PT, PT-AZO, PT-MAD, RU, SE, SI	I1, J1	Potato, tobacco and other Solanaceae, stored products and fields	Astrup (1969), Bentinck (1963), Borg (1899), García Mercet (1926), Huemer and Rabitsch (2002), Janežič (1951), Karsholt and Sinev (2004), Mendes (1910), Pettralia (1949), Roll et al. (2007), Stanev and Kaitazov (1962), Zagulajev (1982)
<i>Storotroga cerealella</i> (Olivier, 1789)	A	Grain feeder	Australasia	1790, DE?	AL, AT, BE, BG, BY, CH, CZ, DE, DK, ES, FR, GB, GR, HR, HU, IS, IT, IT-SAR, IT-SIC, LT, MK, MT, NL, NO, PL, PT, PT-AZO, RO, RU, RS, SE, SI, SK, GB	J1	Stored products	Borg (1932), Dei (1871), Glavendekić et al. (2005), Hrubý (1964), Huemer and Rabitsch (2002), Ivinskis (1993), Janežič (1951), Karsholt and Nielsen (1976), Karsholt and Vieira (2005), Lindeman (1880), Mehl (1977), Ostrauskas and Taluntyte (2004), Šefrová and Laštůvka (2005), Snellen (1898), Tschorbadjiew (1930)
<i>Tecia solanivora</i> (Povolny, 1973)	A	Phytophagous	Neotropics	1999, ES-CAN	ES-CAN	I1, J1	Potato	OEPP/EPPO (2005)
<i>Tuta absoluta</i> (Meyrick, 1917)	A	Phytophagous	Neotropics	2006, ES	AL, BG, CH, ES, ES-BAL, FR, FR-COR, IT, IT-SIC, LT, MT, SI	I1, J1	Tomato	Harizanova et al. (2009), Ostrauskas and Ivinskis (2010), Urbaneja et al. (2007)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
Geometridae								
<i>Pseudocoremia suavis</i> Butler, 1879	A	Phyto- phagous	Australasia (New Zealand)	2007, GB	GB	G3, X25	<i>Nothofagus</i> spp., <i>Podocarpus</i> , <i>Kunzea ericoides</i> , <i>Pinus</i> spp. (mainly <i>P. radiata</i>) and <i>Pseudotsuga menziesii</i>	James (2008), Skinner (2009)
Gracillariidae								
<i>Caloptilia azaleella</i> (Brants, 1913)	A	Phyto- phagous	E Asia	1920, NE	AT, BE, CH, CZ, DE, DK, ES, FR, GB, IT, NL, NO, PL, PT, PT-MAD, RU, SE, SI, SK	I2, J100	<i>Rhododendron</i>	Aguar and Karsholt (2006), Brants (1913), Della Boffa (1931), Emmet et al. (1985), Gomboc (2003), Huemer and Rabitsch (2002), Jørgensen (1982), Lhomme (1946–1963), Opheim and Fjeldså (1983), Šefrová and Laštůvka (2005), Starý (1936)
<i>Parectopa robinella</i> Clemens, 1863	A	Phyto- phagous	North America	1970, IT	AT, BG, CH, CZ, DE, ES, FR, HR, HU, IT, LT, MK, PL, RO, RS, SI, SK, GB	I2, FA, G1, G5	<i>Robinia</i>	Buszko and Nowacki (2000), Huemer and Rabitsch (2002), Ivinskis and Rimsaite (2008), Maček (1982), Marek et al. (1991), Olivella (2001), Vidano (1970)
<i>Phyllocnistis citrella</i> (Stainton, 1856)	A	Phyto- phagous	Asia	1993, ES	AL, CY, ES, FR, GR, IL, IT, IT-SAR, IT-SIC, MT, PT, PT- AZO, PT-MAD, RS	I2	<i>Citrus</i>	de Carvalho and Aguilar (1997), Corley et al. (2000), Garijo and García (1994), Karsholt and Vieira (2005), Mihelakis (1997), Ortu and Delrio (1995), Roll et al. (2007)
<i>Phyllocnistis vitegenella</i> Clemens, 1859	A	Phyto- phagous	North America	1997, IT	AL, IT, SI	I1	<i>Vitis</i>	Posenato et al. (1997), Seljak (2005)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Phyllonorycter issikii</i> (Kumata, 1963)	A	Phyto- phagous	E Asia	1985, RU	AT, BG, BY, CZ, DE, EE, FI, HR, HU, LT, PL, RO, RU, SI, SK, GB	I2, FA, G1, G5	<i>Tilia</i>	Bednova and Belov (1999), Buszko and Nowacki (2000), Ermolaev and Motoshkova (2008), Gomboc et al. (in press), Huemer and Rabitsch (2002), Noreika (1998), Šefrová (2002a), Tokár et al. (2002)
<i>Phyllonorycter leucographella</i> (Zeller, 1850)	A	Phyto- phagous	SW Asia	1850, IT	AT, BE, BG, CH, DE, CZ, DK, FR, GB, GR, HR, HU, IT, NL, PL, RS, SE, SI, SK	I2, FB	Rosaceous bushes, mainly firethorn (<i>Pyracantha</i>)	Baraniak and Walczak (2000), Buhl et al. (1994), Csoka (2001), De Prins (1994), Glavendekić et al. (2005), Huemer and Rabitsch (2002), Maček (1976), Šefrová (1998), Šefrová (1999), Stigter and Frankenhuyzen (1991)
<i>Phyllonorycter platani</i> (Staudinger, 1870)	C	Phyto- phagous	Cryptogenic	1870, IT	AL, AT, BE, BG, CH, CZ, DE, DK, ES, FR, FR-COR, GB, GR, HR, HU, IL, IT, IT-SAR, IT-SIC, MK, NL, PL, PT, PT-MAD, SE, SI, SK, GB	I2, X11, FA, G5	<i>Platanus</i>	Aguiar and Karsholt (2006), Baeta-Neves (1945), Frankenhuyzen (1983), Huemer and Rabitsch (2002), Janmouille (1954), Maček (1968), Roll et al. (2007), Šefrová (2001), Skala (1936), Skala (1937)
<i>Phyllonorycter robinella</i> (Clemens, 1859)	A	Phyto- phagous	North America	1983, CH	AL, AT, BE, BG, CH, CZ, DE, DK, ES, FR, HR, HU, IT, LT, NL, PL, RO, RS, SI, SK, GB	I2, X11, FA, G1, G5	<i>Robinia</i>	Bolchi Serini and Trematerra (1989), Buhl et al. (2005), Buszko and Nowacki (2000), De Prins and Groenen (2001), Glavendekić et al. (2005), Huemer and Rabitsch (2002), Huisman et al. (2003), Ivinskis and Rimsaite (2008), Olivella (2001), Šefrová (2002b), Seljak (1995), Tomov (2003), Whitebread (1990)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
Lycaenidae								
<i>Cacyreus marshalli</i> Butler, 1898	A	Phyto- phagous	Africa	1987, ES- BAL	BE, CH, DE, ES, ES- BAL, FR, FR-COR, GB, IT, IT-SAR, IT- SIC, MT, PT	I2, J1	<i>Pelargonium</i>	Aistleitner (2003), Fuentes Garcia (1997), Sammut (2007), Sarto i Monteys (1992), Trematerra et al. (1997), Troukens (1991), Zilli (1997)
Noctuidae								
<i>Acontia (Emmelia) candefacta</i> (Hübner, 1831) (according to Fauna Europaea)	A	Phyto- phagous	North America	1967, RU,	RU, GB	I1, J6	Ragweed (<i>Ambrosia</i> spp.)	Poltavsky and Artozhkin (2006), Rezbanayi-Reser et al. (2005), Shchurov (2004)
<i>Anaeopteron ephaea</i> (Hampson, 1914)	A	Phyto- phagous	Africa	1987, GR/ ES	FR, FR-COR, GR, ES, BAL		Unknown, a New Guinea species of <i>Ecphaea</i> feeds on legume pods	Rezbanayi-Reser et al. (2004), Robinson et al. (2010), Tautel (2008)
<i>Callopietria maillardii</i> (Guenée, 1862)	C	Phyto- phagous	Cryptogenic (Oriental, Australasia, Pacific and Africa)	1983, DE, DK	DE, DK	I1, I2	Ferns (<i>Adiantum</i> , <i>Lygodium</i> , <i>Nephrolepis</i> , <i>Pilea</i>)	Bathon (1984), Buhl et al. (1985), Karsholt (1994)
<i>Chrysodeixis acuta</i> (Walker, 1858)	C	Phyto- phagous	Cryptogenic (Tropical/ Subtropical)	1998, AT	AT, ES, ES-CAN, FR, GB, IE, PT-MAD	I1, I2	Polyphagous: Tomato, cotton, soybean, banana, tobacco, <i>Citrus</i>	Aguar and Karsholt (2006), Huemer and Rabitsch (2002)
<i>Chrysodeixis eriosoma</i> (Doubleday, 1843)	A	Phyto- phagous	Australasia	2002, DE	DE	I1, I2	Highly polyphagous, foliage and fruit of many field and vegetable crops, ornamentals and weeds: chickpeas, lucerne, maize, potato, sunflower, etc.	Geiter et al. (2001)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Spodoptera litura</i> (Fabricius, 1775)	A	Phyto- phagous	Asia- Tropical	1978, GB	AL, DE, GB	F5, F6, F8, I1, I2, J100	Highly polyphagous, crops and ornamentals	Seymour and Kilby (1978)
Nolidae								
<i>Earias vittella</i> (Fabricius, 1794)	A	Phyto- phagous	Asia	2003, ES	ES	I1, J6	Okra (<i>Abelmoschus esculentus</i>) pods, <i>Gossypium</i> and <i>Hibiscus</i>	Nash (2003)
Nymphalidae								
<i>Danaus chrysippus</i> (Linnaeus, 1758)	A	Phyto- phagous	Africa	1982, ES	ES, ES-CAN, GR, HR, IT-SIC	I1, I2, G, H	<i>Asclepias</i> , <i>Cynanchum acutum</i> , <i>Gomphocarpus fruticosus</i> , <i>Gossypium arborescens</i> , <i>Caralluma burchardii</i>	Baez (1998), Gómez de Aizpúria (2004), Tapia-Domínguez (1982)
<i>Danaus plexippus</i> (Linnaeus, 1758)	A	Phyto- phagous	North America	1887, ES- CAN	ES, ES-CAN, PT, PT- AZO, PT-MAD	I1, I2, G, H	<i>Asclepias</i> , <i>Gomphocarpus fruticosus</i> , <i>Gossypium arborescens</i>	Baez (1998), Gómez de Aizpúria (2004), Neves et al. (2001), Tapia- Domínguez (1982)
Oecophoridae								
<i>Borkhausenia nefrax</i> Hodges, 1974	A	Detriti- vorous	North America	1961, PL	ES, FR, NL, PL	J1	Decaying plant material	Buszko and Vives Moreno (1992), Kuchlein and van Lettow (1999)
<i>Eratophyes amasiella</i> (Herrich-Schäffer, 1854)	A	Detriti- vorous	Asia (Turkey)	1972, NL	BE, DE, DK, NL, SE	J1	Decaying wood	Buhl et al. (1991), Buhl et al. (2004), De Prins (2007), Svensson (2007)
<i>Neomariania rebeli</i> (Walsingham, 1894)	A	Phyto- phagous	Africa, Macaronesia (PT-MAD and ES- CAN)	1986, PT	PT	B	Unknown	Riedl (1990)
<i>Tachystola acrosantha</i> (Meyrick, 1885)	A	Detriti- vorous	Australasia	1908, GB	GB	I2	Withered leaves, leaf- litter	Hind (2000)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
Pterophoridae								
<i>Lantanophaga pusillidactylus</i> (Walker, 1864)	C	Phyto- phagous	Cryptogenic (tropical, type locality, Jamaica)	1973, PT- MAD	ES, IT, PT-AZO, PT- MAD	I2	<i>Lantana camara</i>	Aguiar and Karsholt (2006), Bella and Marchese (2007), Kimber (2008)
<i>Megalorhipida leucodactylus</i> (Fabricius, 1794)	C	Phyto- phagous	Cryptogenic (tropical , type locality Virgin Islands)	1967, IT- SIC	IL, IT-SIC	F5, F8, I2	<i>Acacia neovernica</i> , <i>Mimosa tenuiflora</i> (Fabaceae), <i>Boerhavia diffusa</i> , <i>B. coccinea</i> , <i>B. chinensis</i> , <i>B. repens</i> , <i>Commicarpus tuberosus</i> <i>Okenia hypogaea</i> (Nyctaginaceae), <i>Amaranthus</i> (Amaranthaceae), <i>Scaevola frutescens</i> (Goodeniaceae), <i>Tessaria absinthoides</i> (Asteraceae).	Bella and Ferrauo (2005), Gielis (1996)
Pyralidae + Crambidae								
<i>Agasizella angulipennis</i> (Hampson, 1891)	A	Phyto- phagous	Asia	1977, GB	GB, NL	J1, J100	Aquatic water plants	Goater (1986), Goater et al. (2005)
<i>Arenipses sabella</i> Hampson, 1901	A	Phyto- phagous	Africa (North Africa, Middle east)	1999, ES	ES, FR	I2	Palm trees (<i>Phoenix</i> spp)	Asselbergs (1999), Streito and Martinez (2005)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Cadra cautella</i> (Walker, 1863)	C	Phytophagous	Cryptogenic (type locality: India)	1900, ?	AL, AT, BE, BG, CH, CY, CZ, DK, ES, FI, FR, FR-COR, DE, GB, GR, GR-CRE, HU, IE, IT, IT-SAR, IT-SIC, LV, LT, MT, NL, NO, PL, PT- AZO, PT-MAD, RO, RU, SE, SK	J1	Stored Products: dried fruits, nuts, grain	Aguiar and Karsholt (2006), von Andres (1916), Filipjev (1932), Huemer and Rabitsch (2002), Jannmouille (1965), Karsholt and Vieira (2005), Kenis (2005), Mehl (1977), Ostrauskas and Taluntyte (2004), Reiprich (1990), Šefrová and Laštůvka (2005), Paoli (1922)
<i>Cadra figulella</i> (Gregson, 1871)	C	Detritivorous	Cryptogenic (type locality: Liverpool, England)	1871, GB	AL, AT, BA, BE, BG, BY, CH, CY, CZ, DE, ES, FR, FR- COR, GB, GR, GR- CRE, HR, HU, IE, IT, IT-SAR, IT-SIC, LT, LU, MK, MT, NO, PL, PT, PT- MAD, RO, RS, RU, SE, SI, SK, GB	J1	Dried fruits, raisins, figs	Carnelutti (1975), De Crombrughe (1909), Goater (1986), Huemer and Rabitsch (2002), Kenis (2005), Reiprich and Okáli (1989), Roesler (1973), Šefrová and Laštůvka (2005)
<i>Chilo suppressalis</i> (Walker, 1863)	A	Phytophagous	Asia	1949, ES	ES, FR, FR-COR, RU	I1	Rice (leaves, stems)	Feron (1973), Gerasimov (1949)
<i>Coreya cephalonica</i> (Stainton, 1866)	C	Detritivorous	Cryptogenic (Tropical, subtropical, (type locality, Great Britain)	1866, GB	AT, BE, BG, CH, CZ, DE, DK, ES, FR, GB, GR, IT, IT-SIC, LV, PL, PT, PT-AZO, RO, SE, GB	J1	Stored grain (Poaceae: e.g. rice)	Drensky (1930), Goater (1986), Huemer and Rabitsch (2002), Jannmouille (1938), Karsholt and Vieira (2005), Palm (1986), Šefrová and Laštůvka (2005), Silvestri (1943)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Diaphania perspectalis</i> (Walker, 1859)	A	Phyto- phagous	Asia	2007, DE	CH, DE, FR, NL	I2	<i>Buxus</i>	Brua (2008), Rennwald (2008)
<i>Diploscistus perieresalis</i> (Walker, 1859)	A	Phyto- phagous	Asia	2000, PT	BE, DK, ES, ES-BAL, MT, NL, PT	E3	<i>Carex</i>	Buhl (in press), Muus and Wullaert (2008), Speidel et al. (2007)
<i>Elaphila difflualis</i> (Snellen, 1880)	A	Phyto- phagous	Asia	1978, DK	CZ, DK, FI, GB, NL	J1, J100	Aquatic plants	Buhl et al. (1982), Goater et al. (2005)
<i>Elaphila manilensis</i> Hampson, 1917	A	Phyto- phagous	Asia- Tropical	1978, DK/ GB	CZ, DK, GB	J1, J100	Aquatic plants	Buhl et al. (1982), Vrabec and Heřman (2006)
<i>Elaphila melagnalis</i> (Agassiz, 1978)	A	Phyto- phagous	Asia- Tropical	1978, GB	GB	J100, J1	Aquatic plants	Agassiz (1978b)
<i>Elaphila obliveralis</i> (Walker, 1859)	A	Phyto- phagous	North America	1968, GB	GB	J100	Waterlily	Goater (1986)
<i>Ephesia elutella</i> (Hübner, 1796)	C	Detriti- vorous	Cryptogenic (type locality, Germany)	1796, DE	AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR GB, GR, GR-CRE, HU, IE, IS, IT, IT-SAR, IT-SIC, LT, LV, MK, MT, NL, NO, PL, PT, PT-AZO, PT- MAD, RO, RU, SE, SI, SK	J1	Stored nuts, dried fruits, grain, etc.	Abafi-Aigner et al. (1896), Aguilar and Karsholt (2006), Caruana Gatto (1905), De Sélvs- Longchamps (1844), Filipjev (1932), Huemer and Rabitsch (2002), Karsholt and Vieira (2005), Kenis (2005), Mehl (1977), Petersen (1924), Reid (2008), Šefrová and Laštůvka (2005), Speiser (1903), Paoli (1922)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Ephostia kuehniella</i> Zeller, 1879	C	Detriti- vorous	Cryptogenic (no type locality)	1879, ?	AL, AT, BA, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, GR-CRE, HU, IE, IS, IT, IT- SAR, IT-SIC, LT, LV, ME, MT, NO, PL, PT, PT-AZO, PT- MAD, RO, RS, RU, SE, SI, SK	J1	Stored nuts, dried fruits, grain, etc.	Aguiar and Karsholt (2006), Bolle (1921), Borg (1932), De Crombrughe (1906), Glavendekić et al. (2005), Goater (1986), Hrubý (1964), Huemer and Rabitsch (2002), Janežič (1951), Karsholt and Vieira (2005), Kenis (2005), Mehl (1977), Palm (1986), Šefrová and Laštůvka (2005), Zvezdomb-Zubowsky (1918)
<i>Eustixia pupula</i> Hübner, 1823	A	Phyto- phagous	North America	1997, GB	GB	I1	Cabbage, <i>Lepidium virginicum</i> (Cruciferae)	Budd and Goater (1998)
<i>Herpetogramma licarsialis</i> (Walker, 1859)	C	Phyto- phagous	Cryptogenic (type locality: Malaysia: Sarawak, Old world tropics: Asia and Africa)	1994, CY	CY, ES, MT, PT, PT- MAD, SE	I2, E1	Monocots, turf grasses, pastures	Aguiar and Karsholt (2006), Karsholt and Vieira (2005), Sammut (2000)
<i>Leucinodes orbonalis</i> (Guenée, 1854)	A	Phyto- phagous	Africa	2004, BE	BE	I1	<i>Solanum melongena</i> (eggplant)	Nyst (2004)
<i>Paralipsa gularis</i> (Zeller, 1877)	A	Detriti- vorous	SE Asia (type locality: Japan)	1921	AT, BE, CH, CZ, DE, DK, FR, GB, HU, IT, IT-SIC, LV, NL, NO, SE	J1	Dry fruits, occasionally in imports of nuts for chocolate industry.	De Prins (1983), Giunchi (1957), Goater (1986), Huemer and Rabitsch (2002), Mariani (1941– 1943), Mehl (1977), Palm (1986), Šefrová and Laštůvka (2005),

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Paramylolais transitella</i> (Walker, 1863)	A	Phyto- phagous	North America	1870, AT	AT, IT	I2	<i>Juglans</i>	Huemer and Rabitsch (2002), Trematerra (1988)
<i>Parapomyx bilinealis</i> Snellen, 1876	A	Phyto- phagous	Asia- Tropical	1978, DK	DK, GB, SE	J100	Aquatic plants	Hancock (1984), Karsholt and Nielsen (1998)
<i>Parapomyx crisonalis</i> (Walker, 1859)	A	Phyto- phagous	Asia- Tropical	1979, GB	GB	J100	Aquatic plants	Goater (1986)
<i>Parapomyx diminutalis</i> Snellen, 1880	C	Phyto- phagous	Cryptogenic (Old world tropics: Asia and Africa)	1977, GB	AT, CZ, DK, FI, GB	J100	<i>Nymphaea</i>	Buhl et al. (1982), Goater (1986), Goater et al. (2005), Huemer and Rabitsch (2002)
<i>Parapomyx fluctuosalis</i> (Zeller, 1852)	C	Phyto- phagous	Cryptogenic (ES, Asia and Africa, type locality, Natal)	1979, GB	GB	J100	Aquatic plants	Goater (1986)
<i>Parapomyx obscuralis</i> Grote 1881	A	Phyto- phagous	North America	1967, GB	GB	J100	Aquatic plants	Goater (1986)
<i>Parapomyx polydectalis</i> Walker, 1859	A	Phyto- phagous	Australasia	1979, GB	GB, NL	J100	Aquatic plants	Goater et al. (2005)
<i>Phycita diaphana</i> (Staudinger, 1870)	C	Detriti- vorous	Cryptogenic (type locality: Spain, Malaga)	1870, ES, (2002, PT)	ES, GR, PT	I2, J6	<i>Ricinus communis</i>	Corley et al. (2000)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Plodia interpunctella</i> (Hübner, 1813)	C	Detriti- vorous	Cryptogenic (no type locality)	1813, DE?	AL, AT, BE, BG, BY, CH, CZ, DE, DK, EE, ES, FI, FR, GB, GR, GR-CRE, HU, IE, IS, IT, LV, LT, ME, MK, MT, NL, NO, PL, PT, PT- AZO, PT-MAD, RO, RU, SE, SI, SK, GB	J1	Stored plant products	Aguiar and Karsholt (2006), Borg (1932), Goater (1986), Hrubý (1964), Huemer and Rabitsch (2002), Ivinskis (1976), Karsholt and Vieira (2005), Kenis (2005), Martin (1991), Mehl (1977), Palm (1986), Rebel (1901), Šefrova and Laštůvka (2005), Zolnir (1977)
<i>Pseudarenipes insularum</i> Speidel & Schmitz, 1991	C	Phyto- phagous	Cryptogenic (type locality: Tenerife, Santa Cruz)	2002, FR, 2003, MT	ES, ES-CAN, FR, MT	I2	<i>Phoenix canariensis</i>	Reynaud et al. (2002), Sammut (2003), Sammut (2005)
<i>Spoladea recurvalis</i> (Fabricius, 1775)	A	Phyto- phagous	Tropics: Asia (type locality: India Orientali) South America and Africa	1968, NL (from Canaries)	BE, DK, IT, NL, PT- AZO, PT-MAD	I1, I2	<i>Beta vulgaris</i> , <i>Trianthema postulacastrum</i> , <i>Celosia sp.</i> , <i>Chenopodium sp.</i> , <i>Portulaca sp.</i> , <i>Amaranthus sp.</i>	De Prins (2005), Karsholt and Vieira (2005), Nuss (2010)
<i>Virula edmandsii</i> (Packard, 1865) ssp. <i>sernatilineella</i> Ragonot, 1887	A	Detriti- vorous	North America	late 1940's, DE	DE, DK, FI, NO, SE	J	Honey, pollen, broods in bee nests	Kullberg and Mikkola (2001), Palm (1986), Svensson (1986), Weidner (1971)
Saturniidae								
<i>Antheraea pernyi</i> (Guérin-Ménéville, 1855)	A	Phyto- phagous	Asia	1900, ES	ES, ES-BAL, HU	G1, G5, I2	<i>Quercus</i> , <i>Fagus</i> , <i>Betula</i> , <i>Aesculus</i>	Pittaway (2008)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Antheraea yamamai</i> (Guérin-Ménéville, 1861)	A	Phyto- phagous	Asia	1866-1868, SI	AT, BA, DE, HR, HU, IT, MK, RO, RS, SI	G1, G5, I2	<i>Quercus, Aesculus, Fagus,</i> <i>Castanea</i> , etc.	Blazič et al. (1995), Casale (1973), Glavendekić et al. (2005), Huemer and Rabitsch (2002), Pittaway (2008)
<i>Samia cynthia</i> (Drury, 1773)	A	Phyto- phagous	Asia	1854, IT	AL, AT, CH, DE, ES, FR, HR, IT, SI	I2, X24	<i>Ailanthus</i> and other deciduous trees	Huemer and Rabitsch (2002), Kenis (2005), Kollar(1854), Koster and Sinev (2003), Lepidopterologen Arbeitsgruppe (2000), Quajiat (1904)
Tineidae								
<i>Opogona omoscopia</i> (Meyrick, 1893)	A	Phyto- phagous	Africa	1923, PT- MAD	DK, PT, PT-AZO, PT-MAD, SE	I1, I2J1	Stored products (grain, fruits), plants with mosses	Buhl et al. (1997), Corley (2005), Gaedike and Karsholt (2001), Karsholt and Vieira (2005)
<i>Opogona sacchari</i> (Bojer, 1856)	A	Phyto- phagous	C. Africa	1910, PT- MAD	AL, BE, BG, CH, CZ, DK, ES, ES- CAN, GB, GR, HU, IT, NL, PL, PT-AZO, PT-MAD	I2, J1, J100	<i>Dracaena, Srelizsia,</i> <i>Yucca, Alpinia,</i> <i>Begonia, Bougainvillea,</i> <i>Bromeliaceae, Palms</i> <i>(Chamaedorea etc.),</i> <i>Condyline, Cycas,</i> <i>Hibiscus, Dieffenbachia,</i> <i>Poinsettia, Ficus,</i> <i>Gloxinia, Heliconia,</i> <i>Ippeastrum, Maranta,</i> <i>Philodendron,</i> <i>Sansevieria Saintpaulia,</i> banana plantations (<i>Musa acuminata</i>)	Aguar and Karsholt (2006), Ciampolini (1973), Gaedike and Karsholt (2001), Jannone (1966), Karsholt and Vieira (2005), Sitek (2003), Walsingham (1910), Wolff (1953)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Præcedes atomosella</i> (Walker, 1863)	C	Detriti- vorous	Cryptogenic (type locality: Sierra Leone)	before 1979, PT-MAD	CY, MT, PT-AZO, PT-MAD	F5, F6, F7, I1, I2	<i>Pteridium</i>	Aguiar and Karsholt (2006), Gaedike and Karsholt (2001), Karsholt and Vieira (2005)
<i>Psychoidea filicivora</i> (Meyrick, 1937)	A	Phyto- phagous	Asia (type locality: Ireland)	1909, IE	GB, IE	E5, F3, J100	Ferns (<i>Polystichum setiferum</i> , <i>Dryopteris filix-mas</i> , <i>Phyllitis scolopendrium</i>), often found indoors.	Beirne (1940), Gaedike and Karsholt (2001), Kimber (2008)
<i>Tinea pallescens</i> Stainton, 1851	A	Detriti- vorous	Neotropics (South America)	1840, IE	AT, BE, CZ, DE, DK, FI, FR, GB, HU, IE, IT, LV, NL, NO, RO, RU, SE, SK	J1, J2, J6	Furs, dry fish	Heath and Emmet (1985), Karsholt and Nielsen (1998), Mehl (1977), Šefrová and Laštůvka (2005), Tokár et al. (1999), Vives Moreno (2003)
<i>Tinea translucens</i> Meyrick, 1917	A	Detriti- vorous	S Asia (type locality: Pakistan)	1856, UK	AL, AT, CY, CZ, DE, DK, ES, FR, GB, GR, GR-CRE, HR, HU, IS, IT, IT-SAR, IT-SIC, LV, LT, NO, PT, RO, RU, RS, SK, GB	J1	Stored products, clothes	Buhl et al. (1987), Ivinskis (1993), Opheim and Fjeldså (1983), Pelham-Clinton (1985), Reiprich (1992), Šefrová and Laštůvka (2005), Tokár et al. (2002)
<i>Tineola biselliella</i> (Hummel, 1823)	C	Detriti- vorous	Cryptogenic (type locality, Europe)	1794, SE	AT, BE, BG, BY, CH, CZ, DK, EE, ES, FI, FR, FR-COR, DE, GB, HU, IS, IE, IT, LT, LV, NL, NO, PL, PT, RO, RU, SE, SI, SK, GB	J1, J2	Stored products, clothes	Drenowsky (1909), Hrubý (1964), Karsholt and Nielsen (1998), Mehl (1977), Mendes (1904), Mendes (1905), Palionis (1932), Peterson and Nilssen (2004), Šefrová and Laštůvka (2005)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
Tortricidae								
<i>Acleris undulana</i> (Walsingham, 1900)	A	Phyto- phagous	Asia	1998, ES?	ES, FR	EA, G3, I2, X11	<i>Cedrus</i>	Vives Moreno (2003)
<i>Clepsis peritana</i> (Clemens, 1860)	A	Phyto- phagous	North America	1979, DE	DE, DK, GB, PT- MAD	I1, I2, J100	<i>Citrus, Euphorbia pulcherrima</i> , and low strawberries, and low herbaceous plants	Buhl et al. (1997), Hill et al. (2005)
<i>Cryptophlebia leucoreta</i> (Meyrick, 1927)	A	Phyto- phagous	Africa	1965, FI	IL, FI	I1, J100	<i>Citrus, Macadamia ternstroffia, Ricinus communis</i> , cotton	Bradley (1959), Hamburger et al. (2000), Karvonen (1983)
<i>Dichelita cedricola</i> (Diakonoff, 1974)	A	Phyto- phagous	Asia	POST-2001, FR	FR	G3, I2	<i>Cedrus</i>	Fabre et al. (2001)
<i>Epichoristodes acerbella</i> (Walker, 1864)	A	Phyto- phagous	Africa	1960, DK	DK, ES, FR, GB, IT, IT-SAR, IT-SIC, NO, RS	I2	Polyphagous, especially <i>Dianthus</i>	Costa Seglar and Vives Quadras (1976), Fjeldalen (1965), Glavendekić et al. (2005), Thygesen et al. (1965), Zangheri and Cavallo (1971)
<i>Epinotia algeriensis</i> Chambon, 1990	A	Phyto- phagous	Africa	POST-1990, FR	FR	G3	<i>Cedrus</i>	Chambon et al. (1990)
<i>Epinotia cedricida</i> Diakonoff, 1969	A	Phyto- phagous	Africa	1968, FR	AT, BG, FR	G3, I2	<i>Cedrus</i>	Du Merle (1988), Huemer and Rabitsch (2002), Lelant (1969), Vives Moreno (2003)
<i>Epiphyas postvittana</i> (Walker, 1863)	A	Phyto- phagous	Australasia	1911, GB	GB, PT-AZO	I1, I2	Polyphagous (<i>Malus</i> , etc.)	Agassiz (1996a), Karsholt and Vieira (2005)

Family Species	Status	Regime	Native range	1 st record in Europe and country	Invaded countries	Alien Habitat	Hosts	References
<i>Gnapholita molesta</i> (Busck, 1916)	A	Phyto- phagous	Asia	1920, SI	AL, AT, BA, BG, CH, CZ, DE, DK, ES, FR GR, HU, IT, IT-SAR, IT-SIC, LT, ME, MK, PT-AZO, RO, RS, RU, SI, SK, GB	I2	Rosaceae (<i>Prunus</i> , <i>Pyrus</i> , <i>Malus</i>)	Domínguez García-Tejero (1943), Dufrane (1960), Glavendekić et al. (2005), Hrdý and Krampl (1977), Huemer and Rabitsch (2002), Ivinskis (1993), Janežič (1951), Karsholt and Vieira (2005), Katsogiannos and Koveos (2001), Kyparissoudas (1989), Paoli (1922), Strygina and Shutova (1966), Tzalev (1979)
<i>Lozotaenia cedrivora</i> Chambon, 1990	A	Phyto- phagous	Africa	1968, FR	FR	G3, I2	<i>Cedrus</i>	Fabre (1997)
Yponomeutidae								
<i>Argyresthia cupressella</i> Walsingham, 1890	A	Phyto- phagous	North America	1997, GB	GB	I2	Cupressaceae (<i>Chamaecyparis</i> , <i>Cupressocyparis</i> , <i>Juniperus</i>)	Agassiz (1999)
<i>Argyresthia thuella</i> (Packard, 1871)	A	Phyto- phagous	North America	1971, NL	AT, BE, BG, CH, CZ, DE, HU, NL, PL, SI, SK	I2, FA	<i>Thuja</i> , occasionally other Cupressaceae	De Prins (1983), Frankenhuyzen (1974), Huemer and Rabitsch (2002), Šefrová and Laštůvka (2005), Škerlavaj and Munda (1999), Tokár et al. (1999)
<i>Prays citri</i> (Millière, 1873)	A	Phyto- phagous	Asia	1877, IT	AL, DK, ES, FR, FR-COR, GR, GR-CRE, IL, IT, IT-SAR, IT-SIC, NL, PT, PT-AZO, PT-MAD	I2, J100	<i>Citrus</i>	Buhl et al. (2001), de Carvalho (1995), Franco et al. (2006), Karsholt and Vieira (2005), Liotta and Mineo (1963), Roll et al. (2007)
<i>Prays peregrina</i> Agassiz, 2007	C	Phyto- phagous	Cryptogenic	2003, GB	GB	I2	Unknown	Agassiz (2007)

Table 11.2. List and characteristics of the lepidopteran species expanding within Europe (alien *in* Europe). Country codes abbreviations refer to ISO 3166 (see appendix I). Habitat abbreviations refer to EUNIS (see appendix II). Last update 01/06/2009.

Family <i>Species</i>	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
Arctiidae						
<i>Eilema caniola</i> (Hübner, 1808)	Phyto- phagous	Europe, W Asia & N Africa	AT, BE, CH	B3	Algae and lichens	Foligne (1859), Huemer and Rabitsch (2002), Kenis (2005)
Autostichidae						
<i>Oegoconia novimundi</i> Busck, 1915	Detri- vorous	?, described from North America	AT, GR, HR, PT-AZO, SK, RU	G, F4-9, FA,G, J6	Decaying plant material	Gozmány (2008), Huemer and Rabitsch (2002), Karsholt and Vieira (2005), Tokár et al. (2002)
Coleophoridae						
<i>Coleophora</i> <i>conicipennella</i> (Hübner, 1796)	Phyto- phagous	W Europe	PT-MAD	I1, I2, X24	<i>Malus</i>	Aguiar and Karsholt (2006)
<i>Coleophora laricella</i> (Hübner, 1817)	Phyto- phagous	European Alps	BE, DK, HR, EE, FI, GB, HR, IE, LT, LV, MK, NL, NO, RS, SE	G3	<i>Larix</i>	Bond et al. (2006), De Fré (1858)
<i>Coleophora spinacella</i> Rebel, 1916	Phyto- phagous	C Europe (incl. CZ, AU)	DE, HU, IT, LT, SE, SK	G, I2	<i>Spineae</i>	Baldizzone (pers. comm.), Huemer and Rabitsch (2002), Reiprich and Janovský (1981)
<i>Coleophora versurella</i> Zeller, 1849	Phyto- phagous	Europe	PT-AZO	E1	<i>Atriplex, Chenopodium</i>	Karsholt and Vieira (2005)
Epermeniidae						
<i>Epermenia</i> <i>aequidentellus</i> (Hoffmann, 1867)	Phyto- phagous	C & S Europe	PT-AZO	U	<i>Daucus carota</i>	Karsholt and Vieira (2005)
Ethmiidae						
<i>Ethmia terminella</i> Fletcher, 1938	Phyto- phagous	Europe to N Africa and Asia Minor	SE	B2	<i>Echium vulgare</i>	Svensson (1992)

Family <i>Species</i>	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
Gelechiidae						
<i>Athrips rancidella</i> (Herrich-Schäffer, 1854)	Phyto- phagous	Europe	GB	I2	<i>Cotoneaster horizontalis</i>	Chalmers-Hunt (1985)
<i>Chrysoesthia sexguttella</i> (Thunberg, 1794)	Phyto- phagous	Europe and/or N Africa	PT-AZO	D6	<i>Chenopodium</i>	Karsholt and Vieira (2005)
<i>Gelechia senticetella</i> (Staudinger, 1859)	Phyto- phagous	European Alps	BE, DK, GB, NL, BU	I2, G	<i>Juniperus, Cupressus</i>	De Prins (1989), van Nieukerken et al. (1993), Buhl et al. (2007)
<i>Platyedra subcinerea</i> (Haworth, 1828)	Phyto- phagous	Europe	PT-AZO	I2	<i>Malva sylvestris</i> , seeds, flowers	Karsholt and Vieira (2005)
Geometridae						
<i>Bupalus piniaria</i> (Linnaeus, 1758)	Phyto- phagous	Europe	IE	G3	<i>Pinus</i>	Moffat (1897)
<i>Erannis defoliaria</i> (Clerck, 1759)	Phyto- phagous	Europe	IS	G1, I2	Polyphagous (<i>Quercus, Betula, Ulmus, Acer, Tilia</i>)	Wolff (1971)
<i>Eupithecia carpophagata</i> Staudinger, 1871	Phyto- phagous	Mediterranean	DE	E4	<i>Silene (S. saxifraga, S. rupestris)</i>	Geiter et al. (2001)
<i>Eupithecia indigata</i> (Hübner, 1813)	Phyto- phagous	Europe from Urals W and S to Alps	IE	G3	<i>Pinus sylvestris, Picea, Larix</i>	Skou (1986)
<i>Eupithecia phoeniceata</i> (Rambur, 1834)	Phyto- phagous	Atlantic Europe	BE, GB	I2	<i>Juniperus phoenicea</i>	De Prins (2007)
<i>Eurrantia plummistaria</i> (De Villiers, 1789)	Phyto- phagous	Mediterranean	DE	F6	<i>Dorycnium</i>	Geiter et al. (2001)
<i>Idaea inquinata</i> (Scopoli, 1763)	Phyto- phagous	S Europe to Asia Minor, N Africa	DK, FI, LV, NL, SE	G1, G5, J1	Ever-lasting flowers/dry and withered petals	Naves (1995), Skou (1986), Wolff (1969)
<i>Macaria liturata</i> (Clerck, 1759)	Phyto- phagous	Europe to E Asia	IE	G3	<i>Pinus sylvestris</i>	Roques et al. (2006)

Family Species	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
<i>Operophtera brumata</i> (Linnaeus, 1758)	Phyto- phagous	Europe to Caucasus	IS	G	Deciduous trees	Peterson and Nilssen (2004)
<i>Peribatodes perversaria</i> (Boisduval, 1840)	Phyto- phagous	Europe	DE	F4	<i>Juniperus</i>	Savela (2010)
<i>Thana britannica</i> (Turner, 1925)	Phyto- phagous	Europe	SE	G3	<i>Abies, Pinus</i>	Skou (1986), Svensson (1977)
Gracillariidae						
<i>Camenaria obriidella</i> Deschka & Dimić, 1986	Phyto- phagous	Southern Balkans	AT, BA, BE, BG, BY, CH, CZ, DE, DK, ES, FI, FR, FR-COR, GB, HR, HU, IT, LV, LT, NL, PL, RO, RU, RS, SE, SI, SK, UK	I2, X11, FA, G1	<i>Aesculus hippocastanum</i>	Buhl et al. (2003), Butin and Führer (1994), De Prins and Pupliesene (2000), Hill et al. (2005), Huemer and Rabitsch (2002), Karsholt and Kristensen (2003), Łabanowski and Soika (1998), Laštůvka et al. (1994), Milevoj and Maček (1997), Šefrová and Laštůvka (2001), Stigter et al. (2000), Vives Moreno (2003)
<i>Caloptilia rufipennella</i> (Hübner, 1796)	Phyto- phagous	Europe	LT, LV, NO, SE	I2, G3	<i>Acer pseudoplatanus</i>	Kimber (2008)
<i>Caloptilia roscipennella</i> (Hübner, 1796)	Phyto- phagous	Europe or SW Asia?	AT, BE, CH, CZ, DE, ES, FR, FR-COR, HU, IT, IT- SIC, MD, PL, RO, RU, UK	I2, G3	<i>Juglans regia</i>	Šefrová and Laštůvka (2005)
<i>Phyllonorycter geniculella</i> (Ragonot, 1874)	Phyto- phagous	Europe	GB, LV, LT, SE	I2, G5	<i>Acer pseudoplatanus</i>	Emmet et al. (1985)
<i>Phyllonorycter joannisi</i> (Le Marchand, 1936)	Phyto- phagous	Europe	GB	I2, G5	<i>Acer platanoides</i>	Emmet et al. (1985)

Family Species	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
<i>Phyllonorycter messaniella</i> (Zeller, 1846)	Phyto- phagous	Europe	PT-AZO	I2, G	<i>Quercus</i> , <i>Fagus</i> , <i>Castanea</i>	Aguiar and Karsholt (2006), Karsholt and Vieira (2005)
<i>Phyllonorycter strigulatella</i> (Zeller, 1846)	Phyto- phagous	Europe	GB	G, J1, H1	<i>Alnus incana</i>	Hill et al. (2005)
Lasiocampidae						
<i>Dendrolimus pini</i> (Linnaeus, 1758)	Phyto- phagous	Most of Europe E to Urals and S to S. Italy and Sicily; NW North Africa and Asia Minor to Caucasus and Near East	GB	G3	<i>Pinus</i> spp.	Kimber (2008), Mikkola and Ståhlis (2008)
Lyonetiidae						
<i>Leucoptera malifoliella</i> (O. Costa, 1836)	Phyto- phagous	Mediterranean	PT-MAD	I1, G1, G2	Polyphagous, mostly Rosaceae (<i>Malus</i> , <i>Pyrus</i> , <i>Sorbus</i> , <i>Crataegus</i> , <i>Prunus</i>), <i>Betula</i>	Aguiar and Karsholt (2006)
Nepticulidae						
<i>Acalypttris platani</i> (Müller-Rutz, 1934)	Phyto- phagous	E Balkans	CH, ES, HR, FR, FR-COR, IT, PT, SI,	FA, G, I2, X11	<i>Platanus</i>	van Nieukerken et al. (2004)
<i>Ectoedemia heringella</i> (Mariani, 1939)	Phyto- phagous	S. Europe (Adriatic)	GB	I2, G2	<i>Quercus ilex</i> leaf miner	Hill et al. (2005)
<i>Stigmella atricapitella</i> (Haworth, 1828)	Phyto- phagous	Europe	PT-MAD, ES	G1, G4, X10	<i>Quercus</i>	Aguiar and Karsholt (2006)
<i>Stigmella aurella</i> (Fabricius, 1775)	Phyto- phagous	Europe	PT-AZO	I1	<i>Rubus</i>	Karsholt and Vieira (2005)
<i>Stigmella cenifoliella</i> (Zeller, 1848)	Phyto- phagous	Europe	PT-MAD	B1, X24, X25	<i>Rosa</i>	Aguiar and Karsholt (2006)

Family <i>Species</i>	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
<i>Earias vernana</i> (Fabricius, 1787)	Phyto- phagous	C&S Europe & W Asia	SE	G,FA	<i>Populus alba</i>	Hyden et al. (2006)
Notodontidae						
<i>Thaumetopoea pityocampa</i> (Denis & Schiff., 1775)	Phyto- phagous	S Europe & N Africa	IT-SAR	G3	<i>Pinus</i> spp	Mendes (1905)
Nymphalidae						
<i>Pararge aegeria</i> (Linnaeus, 1758)	Phyto- phagous	Europe to E Asia and N Africa	PT-MAD	G2,X10	<i>Brachypodium sylvaticum</i> (Poaceae)	Aguiar and Karsholt (2006), Jones and Lace (1992)
Oecophoridae						
<i>Endrosia sarcitrella</i> (Linnaeus, 1758)	Detri- vorous	Mediterranean?	AT, BE, BY, CH, CZ, DE, DK, EE, FI, GB, IE, IS, LT, LV, NL, NO, PL, RO, SE, SK	J1, G	Carpets, corks of wine bottles, dried plant material, dried foodstuffs indoors. Occurs outdoors in dried bracket-fungi on trees	Abafi-Aigner et al. (1896), Hrubý (1964), Martin (1991), Mehl (1977), Šefrová and Laštůvka (2005), Ulmer et al. (1918)
<i>Hofmannophila pseudopretella</i> (Stainton, 1849)	Detri- vorous	Mediterranean?	AT, BE, BY, CH, CZ, DE, DK, EE, FI, GB, IS, IE, LT, LV, NL, NO, PL, PT, RO, SE, SK	J1, I2	Fabrics, including carpets, upholstery, leather and books, but more especially infesting dried foodstuffs	Amsel (1959), Hill et al. (2005), Hrubý (1964), Jürivete et al. (2000), Mehl (1977), Šefrová and Laštůvka (2005)
Pieridae						
<i>Pieris rapae</i> (Linnaeus, 1758)	Phyto- phagous	Palaeartic and N America, Australia	PT-MAD	X22, X23, X24, X25	<i>Brassica</i>	Aguiar and Karsholt (2006)
Plutellidae						

Family Species	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
<i>Plutella porrectella</i> (Linnaeus, 1758)	Phyto- phagous	Europe and Asia Minor, expanding throughout N America	SE	E5, I2	<i>Hesperis matronalis</i>	Gustaffson (2010)
Pterophoridae						
<i>Emmelina monodactyla</i> (Linnaeus, 1758)	Phyto- phagous	Europe, Africa, Asia, and/or N America, Mexico	PT-AZO	E, E, I2	Bindweeds (<i>Convolvulus</i> and <i>Calystegia</i> spp.), occasionally Morning glory (<i>Ipomoea</i>), <i>Chenopodium</i> and <i>Atriplex</i>	Karsholt and Vieira (2005)
<i>Stenoptilia millieridactylus</i> (Bruand, 1861)	Phyto- phagous	Atlantic Europe	GB, IE	I2	Wild Mossy saxifrage (<i>Saxifraga hypnoides</i>)	Hill et al. (2005)
Pyralidae + Crambidae						
<i>Aglossa caprealis</i> (Hübner, 1809)	Detri- vorous	Mediterranean	AT, BE, CZ, DE, DK, GB, NL, PL, PT-AZO, PT-MAD	J1	Stored Products	Aguar and Karsholt (2006), Buhl et al. (2007), Karsholt and Vieira (2005), Šefrová and Laštůvka (2005)
<i>Apomyelois ceratoniae</i> (Zeller, 1839)	Detri- vorous	Medi- terranean?	AT, BE, CH, CZ, DE, DK, GB, HU, NL, NO, PL, RO, RU, SE, UK	J1	Stored products: dry fruits, dates, nuts, carob, pistachio	Palm (1986), Sterneck and Zimmermann (1933)
<i>Cadra calidella</i> (Guenée, 1845)	Detri- vorous	Mediterranean	AT, BE, CH, CZ, DE, DK, FI, GB, IE, NL, NO, RO, SE, SK	J1	Dried fruits, nuts, figs	Hance (1991), Huemer and Rabitsch (2002), Mehl (1979), Palm (1986), Reiprich (1989), Vlach (1938)

Family Species	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
<i>Duponchelia fovealis</i> Zeller, 1847	Phyto- phagous	Mediterranean and Canary Islands	BE, CZ, DE, DK, FI, GB, NL, NO, SE	J100, J1	Polyphagous in greenhouses (<i>Begonia</i> , <i>Gerbera</i> , <i>Cyclamen</i> , <i>Anthurium</i> , <i>Kalanchoe</i> , <i>Poinsettia</i> , <i>Rosa</i> , aquatic plants, maize, pepper and other vegetables), can reproduce outside, but surviving winters	Buhl et al. (2006), Deurs (1958), Huisman and Koster (1995), Marek and Bártová (1998)
<i>Euclasta varii</i> (Popescu-Gorj & Constantinescu, 1973)	Phyto- phagous	SW Europe (Spain)	MT	F6	Palm trees (<i>Phoenix canariensis</i> and <i>P. dactylifera</i>)	Sammut (2005)
<i>Sclerocona acutellus</i> (Eversmann, 1842)	Phyto- phagous	S & C Europe to Asia (apparently expanding to Siberia, China and E USA)	GB	B, E	Grass stems used for thatching	Wagner et al. (2003)
Saturniidae						
<i>Gnathia isabellae</i> Graells, 1849	Phyto- phagous	SW Europe (Spain, France)	CH	G3	<i>Pinus sylvestris</i>	Lepidopterologen Arbeitsgruppe (2000)
Sesiidae						
<i>Pennisetia hylaeformis</i> (Laspeyres, 1801)	Phyto- phagous	Europe to W Asia	GB	I1, I2	<i>Ribes</i>	Reiprich (1980)
<i>Synanthedon andrenaefomis</i> (Laspeyres, 1801)	Phyto- phagous	Europe &/or Asia Minor to W Asia	SE	I2	<i>Viburnum lantana</i>	Torstenius and Lindmark (2000)
<i>Synanthedon myopaeformis</i> (Borkhausen, 1789)	Phyto- phagous	SC Europe &/ or Asia Minor and Egypt	PT-MAD	I2	<i>Malus</i>	Aguiar and Karsholt (2006)

Family <i>Species</i>	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
Tineidae						
<i>Haplotinea ditella</i> (Pierce & Mercalfe, 1938)	Detri- vorous	Mediterranean	AT, BE, CZ, DE, DK, FI, GB, LT, NL, NO, PL, RU, SE, SK	J1	Cereals	Heath and Emmet (1985), Ivinskis (1988), Reiprich (1991), Šefrová and Laštůvka (2005)
<i>Haplotinea insectella</i> (Fabricius, 1794)	Detri- vorous	Mediterranean	AT, BE, CH, CZ, DE, DK, FI, GB, IE, LT, NL, NO, PL, RU, SE, SK	J1	Stored products	Heath and Emmet (1985), Hrubý (1964), Ivinskis and Mozúraitis (1995), Mehl (1977), Šefrová and Laštůvka (2005)
<i>Tinea murariella</i> Staudinger, 1859	Detri- vorous	Mediterranean?	CH, ES, FR, GB, HR, IT, IT-SIC, NO, PT, PT-AZO, PT-MAD, RO	J1	Stored products	Adams (1979), Gaedike and Karsholt (2001), Karsholt and Vieira (2005), Opheim and Fjeldså (1983)
<i>Trichophaga tapetzella</i> (Linnaeus, 1758)	Detri- vorous	Mediterranean?	AL, AT, BE, BG, BY, CH, CY, CZ, DE, DK, EE, FI, FR, FR-COR, GB, GR-CRE, HR, IE, IT-SAR, LU, LV, LT, NL, NO, PL, PT-AZO, SE, SI, SK, UK	J1	Stored products	De Graaf (1851), Hrubý (1964), Karsholt and Vieira (2005), Lederer (1863), Palionis (1932), Robinson and Nielsen (1989), Šefrová and Laštůvka (2005)
Tortricidae						
<i>Acleris variegana</i> (Denis & Schiffmüller, 1775)	Phyto- phagous	Europe	PT-AZO	FB	<i>Rosa</i>	Karsholt and Vieira (2005)
<i>Adoxophyes orana</i> (Fischer von Röslerstamm, 1834)	Phyto- phagous	Europe	GB	I1, I2	Polyphagous, fruit trees (<i>Prunus</i> , <i>Malus</i> , <i>Rosa</i>) and deciduous (<i>Alnus</i> , <i>Betula</i> , <i>Populus</i> , <i>Salix</i>)	Bradley et al. (1973)

Family Species	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
<i>Cacocimorpha prunubana</i> (Hübner, 1799)	Phyto- phagous	S Europe	BE, CH, CZ, DE, DK, GB, HU, IE, LT, LU, NL	FB, I2, X11, G1, J100	Polyphagous, especially on <i>Dianthus</i> but also on <i>Acacia</i> , <i>Acer</i> , <i>Chrysanthemum</i> , <i>Citrus</i> , <i>Coriaria</i> , <i>Coronilla</i> , <i>Euphorbia</i> , <i>Ilex</i> , <i>Jasminum</i> , <i>Laurus</i> , <i>Mahonia</i> , <i>Malus</i> , <i>Olea</i> , <i>Pelargonium</i> , <i>Populus</i> , <i>Prunus</i> , <i>Rhododendron</i> , <i>Rosa</i> , <i>Rubus</i> , <i>Syringa</i>	Billen (1999), de Carvalho (1995), Glavendekić et al. (2005), Ivinskis (2004), Janmoulle (1974), Thygesen (1963)
<i>Clavigesta sylvestrana</i> (Curtis, 1850)	Phyto- phagous	Europe	PT-AZO, PT-MAD	G3	<i>Pinus</i>	Aguar and Karsholt (2006), Karsholt and Vieira (2005)
<i>Cydia gruneriana</i> (Ratzeburg, 1868)	Phyto- phagous	E Europe	BE, DK, SE	I2	<i>Larix</i>	Falck and Karsholt (1993), Groenen and De Prins (2004)
<i>Cydia illutana</i> (Herrich-Schäffer, 1851)	Phyto- phagous	Europe	GB	G3	<i>Larix</i> , <i>Picea</i>	Hill et al. (2005)
<i>Cydia milleniana</i> Adamczewski, 1967	Phyto- phagous	Europe and Asia	BE, DK, GB	G3	<i>Larix</i>	Hill et al. (2005), Buhl et al. (2004)
<i>Cydia pactolana</i> (Zeller, 1840)	Phyto- phagous	Europe	GB	G3	<i>Picea</i>	Hill et al. (2005)
<i>Cydia pomonella</i> (Linnaeus, 1758)	Phyto- phagous	Europe, expanding to E USA	PT-AZO, PT-MAD	I1	<i>Malus</i>	Aguar and Karsholt (2006), Karsholt and Vieira (2005)
<i>Cydia splendana</i> (Hübner, 1799)	Phyto- phagous	Europe	PT-AZO, PT-MAD	G1	<i>Castanea</i> , <i>Quercus</i> but also <i>Fagus</i> and <i>Juglans</i> , fruit borer	Aguar and Karsholt (2006), Karsholt and Vieira (2005)
<i>Cydia strobilella</i> (Linnaeus, 1758)	Phyto- phagous	Europe	NL		<i>Picea</i> , cone borer	Coldewey and Vári (1947)
<i>Notocelia rosacolana</i> (Doubleday, 1850)	Phyto- phagous	Europe	IS	I2	<i>Rosa</i>	

Family Species	Regime	Native range	Invaded countries	Alien Habitat	Hosts	Refs
<i>Rhopobota naevana</i> (Hübner, 1817)	Phyto- phagous	Europe	PT-AZO	I2	Holly (<i>Ilex aquifolium</i>) and blueberry (<i>Vaccinium myrtillus</i>)	Karsholt and Vieira (2005)
<i>Rhyacionia buoliana</i> (Denis & Schiffmüller, 1775)	Phyto- phagous	Europe expanding to N America	PT-MAD	X15,X16	<i>Pinus</i>	Aguar and Karsholt (2006)
<i>Selania leplastriana</i> (Curtis, 1831)	Phyto- phagous	Mediterranean and/or N Africa, Asia Minor	SE	I1	<i>Brassica</i>	Svensson (2006)
Yponomeutidae						
<i>Argyresthia laevigatella</i> (Heydenreich, 1851)	Phyto- phagous	N or C Europe &/or Japan	DK, FI, GB, HU, IE, LT, LV, NL, NO, SE	G3	<i>Larix</i> shoots	Kimber (2008)
<i>Argyresthia trifasciata</i> Staudinger, 1871	Phyto- phagous	European Alps	AT, BE, CZ, DE, DK, GB, HU, LV, NL, PL, SE, SI, SK	I2, FA	<i>Juniperus</i> (not spiked species), very occasionally <i>Cupressocypariss</i> , <i>Chamaecypariss</i>	Buhl et al. (1998), De Prins (1996), Gomboc (2003), Huemer and Rabitsch (2002), Sefrová and Laštůvka (2005)
<i>Prays oleae</i> (Bernard, 1788)	Phyto- phagous	Mediterranean	PT-AZO	I2, J100	<i>Olea</i> (240) trees	Karsholt and Vieira (2005)
<i>Zelleria oleastrella</i> (Millière, 1864)	Phyto- phagous	Mediterranean	GB, PT-MAD	I2, J100	<i>Olea</i> (240) trees	Aguar and Karsholt (2006)
Zygaenidae						
<i>Therapsimima ampelophaga</i> (Bayle- Barelle, 1808)	Phyto- phagous	Mediterranean	AT	I1	<i>Vitis vinifera</i>	Huemer and Rabitsch (2002), Prinz (1907), Tarmann (1998)